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(54) **CONGESTION MEASUREMENT METHOD AND NETWORK NODE**

(57) This application provides a congestion measurement method. The method includes: receiving a first delimitation packet, where the first delimitation packet includes a first identifier, and the first identifier is used to indicate a moment at which the second network node sends the first delimitation packet; collecting, based on the first delimitation packet, statistics about a congestion status of the first network node by using a first time interval as a periodicity, where the first time interval is a time interval at which the second network node sends two neighboring delimitation packets; and sending a first-type statistics packet to the second network node by using the first time interval as a periodicity.

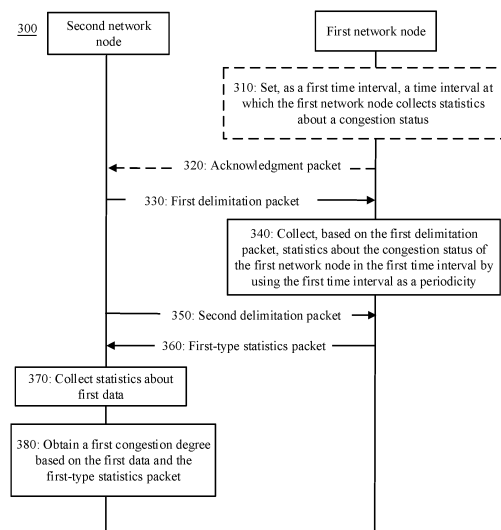


FIG. 3

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Description

[0001] This application claims priority to Chinese Patent Application No. 201910586703.X, filed with the China National Intellectual Property Administration on July 01, 2019 and entitled "CONGESTION MEASUREMENT METHOD AND NETWORK NODE", which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] This application relates to the communication field, and more specifically, to a congestion measurement method and a network node.

BACKGROUND

[0003] With development of the Internet, users have higher requirements on network quality. Network providers need tools and methods for measuring networks to monitor the networks and control network quality to meet user needs. Currently, network adjustment is performed on a data plane, to provide network repair requirements, but a congestion status of a network path needs to be sensed at a millisecond level, so as to adjust traffic to reduce packet loss.

SUMMARY

[0004] This application provides a congestion measurement method and a network node, to improve congestion measurement accuracy, so as to meet adjustment requirements on a data plane.

[0005] According to a first aspect, a congestion measurement method is provided. The method is performed in a communication system including a first network node and a second network node, is applied to the first network node, and includes: receiving a first delimitation packet, where the first delimitation packet includes a first identifier, and the first identifier is used to indicate a moment at which the second network node sends the first delimitation packet; collecting, based on the first delimitation packet, statistics about a congestion status of the first network node by using a first time interval as a periodicity, where the first time interval is a time interval at which the second network node sends two neighboring delimitation packets; and sending a first-type statistics packet to the second network node by using the first time interval as a periodicity, where the first-type statistics packet includes the first identifier, and the first-type statistics packet is used to indicate the congestion status of the first network node in the first time interval.

[0006] The first network node collects statistics about the congestion status of the first network node at an equal time interval based on the first delimitation packet, and sends a congestion statistics status to the second network node at an equal time interval, thereby improving congestion measurement accuracy and meeting adjust-

ment requirements for the congestion status on a data plane.

[0007] With reference to the first aspect, in a possible implementation, the first-type statistics packet includes a first receiving rate of the first network node in the first time interval.

[0008] With reference to the first aspect, in a possible implementation, the first-type statistics packet includes a third identifier, a fourth identifier, and a quantity of data packets that are received by the first network node, where statistics about the quantity of data packets are collected by the first network node, the third identifier is used to indicate a moment at which the first network node receives the first delimitation packet, and the fourth identifier is used to indicate a moment at which the first network node sends the first-type statistics packet.

[0009] The first identifier includes a second moment, so that the first network node can obtain a correspondence between the statistics packet sent by the first network node and data about which the first network node collects statistics, thereby improving congestion measurement accuracy.

[0010] With reference to the first aspect, in a possible implementation, the method further includes: receiving a second delimitation packet at a third moment, where the second delimitation packet includes a second identifier, and the second identifier is used to indicate a moment at which the second network node sends the second delimitation packet; the second delimitation packet and the first delimitation packet are two neighboring delimitation packets; and a time interval between the third moment and a first moment is greater than the first time interval, and the first moment is a moment at which the first network node receives the first delimitation packet; and finishing collecting statistics about the congestion status of the first network node based on the second delimitation packet.

[0011] With reference to the first aspect, in a possible implementation, when the third moment and a start moment or an end moment of the first time interval do not overlap, after the finishing collecting statistics about the congestion status of the first network node based on the second delimitation packet, the method further includes: sending a second-type statistics packet to the second network node at the third moment, where the second-type statistics packet includes the first identifier, and the second-type statistics packet is used to indicate a congestion status of the first network node in a time interval between the third moment and the start moment of the first time interval in which the third moment is located.

[0012] When the third moment and the start moment or the end moment of the first time interval do not overlap, the first network node sends the second-type statistics packet to the second network node at the third moment. The second-type statistics packet is used to indicate the congestion status of the first network node in the time interval between the third moment and the start moment of the first time interval in which the third moment is lo-

cated, so that the second network node obtains the congestion status of the first network node.

[0013] With reference to the first aspect, in a possible implementation, the second-type statistics packet includes a second receiving rate of the first network node in the time interval between the third moment and the start moment of the first time interval in which the third moment is located.

[0014] With reference to the first aspect, in a possible implementation, the second-type statistics packet includes a fifth identifier, a sixth identifier, and the quantity of data packets that are received by the first network node, where statistics about the quantity of data packets are collected by the first network node, the fifth identifier is used to indicate the start moment of the first time interval in which the third moment is located, and the sixth identifier is used to indicate the third moment.

[0015] With reference to the first aspect, in a possible implementation, when the third moment and the start moment or the end moment of the first time interval do not overlap, the method further includes: collecting statistics about a congestion status in a time interval between the third moment and the end moment of the first time interval in which the third moment is located; and sending a third-type statistics packet to the second network node at the end moment of the first time interval in which the third moment is located, where the third-type statistics packet is used to indicate the congestion status of the first network node in the time interval between the third moment and the end moment of the first time interval in which the third moment is located, and the third-type statistics packet includes the second identifier.

[0016] When the third moment and the start moment or the end moment of the first time interval do not overlap, the first network node collects statistics about the congestion status in the time interval between the third moment and the end moment of the first time interval in which the third moment is located, and sends the third-type statistics packet to the second network node at the end moment of the first time interval in which the third moment is located, so that the congestion status of the first network node in the time interval between the third moment and the end moment of the first time interval in which the third moment is located is sent to the second network node in time, so that the second network node obtains the corresponding congestion status, thereby improving congestion measurement accuracy.

[0017] With reference to the first aspect, in a possible implementation, the third-type statistics packet includes a third receiving rate of the first network node in the time interval between the third moment and the end moment of the first time interval in which the third moment is located.

[0018] With reference to the first aspect, in a possible implementation, the third-type statistics packet includes the sixth identifier, a seventh identifier, and the quantity of data packets that are received by the first network node, where statistics about the quantity of data packets

are collected by the first network node, and the seventh identifier is used to indicate the end moment of the first time interval in which the third moment is located.

[0019] With reference to the first aspect, in a possible implementation, the method further includes: setting, as the first time interval, a time interval at which the first network node collects statistics about the congestion status.

[0020] The time interval at which the first network node collects statistics about the congestion status is set as the first time interval, thereby ensuring that the first network node reports the statistics packet at an equal time interval, so as to meet adjustment requirements on a data plane.

[0021] With reference to the first aspect, in a possible implementation, the setting, as the first time interval, a time interval at which the first network node collects statistics about the congestion status includes: receiving a setting packet, where the setting packet is used to indicate the time interval at which the first network node collects statistics about the congestion status, and the setting packet includes the first time interval; and setting, as the first time interval based on the setting packet, the time interval at which the first network node collects statistics about the congestion status.

[0022] The first network node sets, as the first time interval by using the received setting packet, the time interval at which the first network node collects statistics about the congestion status, to flexibly implement uniform time intervals at which the first network node collects statistics about the congestion status.

[0023] With reference to the first aspect, in a possible implementation, the setting, as the first time interval, a time interval at which the first network node collects statistics about the congestion status includes: setting, as the first time interval based on a communication protocol, the time interval at which the first network node collects statistics about the congestion status.

[0024] The first network node sets, as the first time interval according to stipulations in the communication protocol, the time interval at which the first network node collects statistics about the congestion status, thereby reducing signaling overheads.

[0025] With reference to the first aspect, in a possible implementation, the method further includes: sending an acknowledgment packet, where the acknowledgment packet is used to indicate that the first network node has set the time interval at which the first network node collects statistics about the congestion status.

[0026] The first network node indicates, by sending the acknowledgment packet, that the first network node has set the time interval at which the first network node collects statistics about the congestion status, thereby facilitating subsequent statistical operations.

[0027] According to a second aspect, a congestion measurement method is provided. The method is performed in a communication system including a first network node and a second network node, is applied to the

second network node, and includes: sending a first delimitation packet, where the first delimitation packet includes a first identifier, and the first identifier is used to indicate a moment at which the second network node sends the first delimitation packet; sending a second delimitation packet, where the second delimitation packet includes a second identifier, the second identifier is used to indicate a moment at which the second network node sends the second delimitation packet, the second delimitation packet and the first delimitation packet are two neighboring delimitation packets, and a time interval at which the second network node sends the two neighboring delimitation packets is a first time interval; collecting statistics about first data based on the first delimitation packet and the second delimitation packet, where the first data is used to indicate a congestion status in the first time interval; receiving, by using the first time interval as a periodicity, a first-type statistics packet sent by the first network node, where the first-type statistics packet includes the first identifier, and the first-type statistics packet is used to indicate the congestion status of the first network node in the first time interval; and obtaining a first congestion degree based on the first data and the first-type statistics packet, where the first congestion degree is used to indicate a congestion degree in the first time interval.

[0028] The second network node determines a congestion status of a path between the first network node and the second network node by collecting statistics about a congestion status of the second network node in a first time interval between moments at which two neighboring delimitation packets are sent and a congestion status of the first network node in a first time interval between moments at which the first network node receives the two neighboring delimitation packets, thereby improving congestion measurement accuracy and meeting adjustment requirements for the congestion status on a data plane.

[0029] With reference to the second aspect, in a possible implementation, the first-type statistics packet includes a first receiving rate of the first network node in the first time interval.

[0030] With reference to the second aspect, in a possible implementation, the first-type statistics packet includes a third identifier, a fourth identifier, and a quantity of data packets that are received by the first network node, where statistics about the quantity of data packets are collected by the first network node, the third identifier is used to indicate a moment at which the first network node receives the first delimitation packet, and the fourth identifier is used to indicate a moment at which the first network node sends the first-type statistics packet.

[0031] With reference to the second aspect, in a possible implementation, the first identifier includes a second moment, and the second moment is a moment at which the second network node sends the first delimitation packet.

[0032] With reference to the second aspect, in a pos-

sible implementation, the second identifier includes a fourth moment, and the fourth moment is a moment at which the second network node sends the second delimitation packet.

[0033] With reference to the second aspect, in a possible implementation, the first data is a first sending rate of the second network node in the first time interval between the second moment and the fourth moment; or the first data is a quantity of data packets that are sent by the second network node in the first time interval between the second moment and the fourth moment.

[0034] With reference to the second aspect, in a possible implementation, the method further includes: receiving a second-type statistics packet, where the second-type statistics packet includes the first identifier, the second-type statistics packet is used to indicate a congestion status of the first network node in a time interval between a third moment and a start moment of the first time interval in which the third moment is located, and the third moment is a moment at which the first network node receives the second delimitation packet; and obtaining a second congestion degree based on the first data and the second-type statistics packet, where the second congestion degree is used to indicate a congestion degree in the time interval between the third moment and the start moment of the first time interval in which the third moment is located.

[0035] With reference to the second aspect, in a possible implementation, the second-type statistics packet includes a second receiving rate of the first network node in the time interval between the third moment and the start moment of the first time interval in which the third moment is located.

[0036] With reference to the second aspect, in a possible implementation, the second-type statistics packet includes a fifth identifier, a sixth identifier, and the quantity of data packets that are received by the first network node, where statistics about the quantity of data packets are collected by the first network node, the fifth identifier is used to indicate the start moment of the first time interval in which the third moment is located, the sixth identifier is used to indicate the third moment, and the third moment is the moment at which the first network node receives the second delimitation packet.

[0037] With reference to the second aspect, in a possible implementation, the method further includes: receiving a third-type statistics packet, where the third-type statistics packet includes the second identifier, and the third-type statistics packet is used to indicate a congestion status of the first network node in a time interval between the third moment and an end moment of the first time interval in which the third moment is located; collecting statistics about second data, where the second data is used to indicate a congestion status in the first time interval between a fourth moment and a fifth moment, the fourth moment is a moment at which the second network node sends the second delimitation packet, a time interval between the fifth moment and the fourth

moment is the first time interval, and the fifth moment is later than the fourth moment; obtaining a third congestion degree based on the second data and the third-type statistics packet, where the third congestion degree is used to indicate a congestion degree in the time interval between the third moment and the end moment of the first time interval in which the third moment is located; and obtaining a fourth congestion degree based on the second congestion degree and the third congestion degree, where the fourth congestion degree is used to indicate a congestion degree in the first time interval in which the third moment is located.

[0038] First, the second network node receives the third-type statistics packet that is sent by the first network node at the end moment of the first time interval in which the third moment is located, and collects statistics about the second data, where the second data is the congestion status of the second network node in the time interval between the fourth moment and the fifth moment; second, the congestion degree in the time interval between the third moment and the end moment of the first time interval in which the third moment is located is determined based on the second data and the third-type statistics packet; and finally, the congestion degree in the first time interval in which the third moment is located is obtained based on the congestion degree in the time interval between the third moment and the start moment of the first time interval in which the third moment is located and the congestion degree in the time interval between the third moment and the end moment of the first time interval in which the third moment is located, thereby improving congestion measurement accuracy.

[0039] With reference to the second aspect, in a possible implementation, that the second network node obtains the fourth congestion degree based on the second congestion degree and the third congestion degree includes: The second network node determines an average value of the second congestion degree and the third congestion degree as the fourth congestion degree.

[0040] With reference to the second aspect, in a possible implementation, the second data is a second sending rate in the time interval between the fourth moment and the fifth moment; or the second data is a quantity of data packets that are sent by the second network node in the time interval between the fourth moment and the fifth moment.

[0041] With reference to the second aspect, in a possible implementation, the third-type statistics packet includes a third receiving rate of the first network node in the time interval between the third moment and the end moment of the first time interval in which the third moment is located.

[0042] With reference to the second aspect, in a possible implementation, the third-type statistics packet includes the sixth identifier, a seventh identifier, and the quantity of data packets that are received by the first network node, where statistics about the quantity of data packets are collected by the first network node, and the

seventh identifier is used to indicate the end moment of the first time interval in which the third moment is located.

[0043] With reference to the second aspect, in a possible implementation, the method further includes: sending a setting packet, where the setting packet is used to indicate a time interval at which the first network node collects statistics about the congestion status, and the setting packet includes the first time interval.

[0044] With reference to the second aspect, in a possible implementation, the method further includes: receiving an acknowledgment packet, where the acknowledgment packet is used to indicate that the first network node has set the time interval at which the first network node collects statistics about the congestion status.

[0045] According to a third aspect, a network node is provided. The network node includes a first network node and a second network node, the network node is the first network node, and the network node includes: a receiving module, configured to receive a first delimitation packet, where the first delimitation packet includes a first identifier, and the first identifier is used to indicate a moment at which the second network node sends the first delimitation packet; a processing module, configured to collect, based on the first delimitation packet, statistics about a congestion status of the network node by using a first time interval as a periodicity, where the first time interval is a time interval at which the second network node sends two neighboring delimitation packets; and a sending module, configured to send a first-type statistics packet to the second network node by using the first time interval as a periodicity, where the first-type statistics packet includes the first identifier, and the first-type statistics packet is used to indicate a congestion status of the network node in the first time interval.

[0046] With reference to the third aspect, in a possible implementation, the first-type statistics packet includes a first receiving rate of the network node in the first time interval.

[0047] With reference to the third aspect, in a possible implementation, the first-type statistics packet includes a third identifier, a fourth identifier, and a quantity of data packets that are received by the network node, where statistics about the quantity of data packets are collected by the network node, the third identifier is used to indicate a moment at which the network node receives the first delimitation packet, and the fourth identifier is used to indicate a moment at which the network node sends the first-type statistics packet.

[0048] With reference to the third aspect, in a possible implementation, the first identifier includes a second moment.

[0049] With reference to the third aspect, in a possible implementation, the receiving module is further configured to: receive a second delimitation packet at a third moment, where the second delimitation packet includes a second identifier, and the second identifier is used to indicate a moment at which the second network node sends the second delimitation packet; the second delimitation

itation packet and the first delimitation packet are two neighboring delimitation packets; a time interval between the third moment and a first moment is greater than the first time interval, and the first moment is a moment at which the network node receives the first delimitation packet; and the processing module is further configured to: finish collecting statistics about the congestion status of the network node based on the second delimitation packet.

[0050] With reference to the third aspect, in a possible implementation, the second identifier includes a fourth moment.

[0051] With reference to the third aspect, in a possible implementation, when the third moment and a start moment or an end moment of the first time interval do not overlap, the sending module is further configured to: send a second-type statistics packet to the second network node at the third moment, where the second-type statistics packet includes the first identifier, and the second-type statistics packet is used to indicate a congestion status of the network node in a time interval between the third moment and the start moment of the first time interval in which the third moment is located.

[0052] With reference to the third aspect, in a possible implementation, the second-type statistics packet includes a second receiving rate of the network node in the time interval between the third moment and the start moment of the first time interval in which the third moment is located.

[0053] With reference to the third aspect, in a possible implementation, the second-type statistics packet includes a fifth identifier, a sixth identifier, and the quantity of data packets that are received by the network node, where statistics about the quantity of data packets are collected by the network node, the fifth identifier is used to indicate the start moment of the first time interval in which the third moment is located, and the sixth identifier is used to indicate the third moment.

[0054] With reference to the third aspect, in a possible implementation, when the third moment and the start moment or the end moment of the first time interval do not overlap, the processing module is further configured to: collect statistics about a congestion status in a time interval between the third moment and the end moment of the first time interval in which the third moment is located; and the sending module is further configured to: send a third-type statistics packet to the second network node at the end moment of the first time interval in which the third moment is located, where the third-type statistics packet includes the second identifier, and the third-type statistics packet is used to indicate the congestion status of the network node in the time interval between the third moment and the end moment of the first time interval in which the third moment is located.

[0055] With reference to the third aspect, in a possible implementation, the third-type statistics packet includes a third receiving rate of the network node in the time interval between the third moment and the end moment of

the first time interval in which the third moment is located.

[0056] With reference to the third aspect, in a possible implementation, the third-type statistics packet includes the sixth identifier, a seventh identifier, and the quantity of data packets that are received by the network node, where statistics about the quantity of data packets are collected by the network node, and the seventh identifier is used to indicate the end moment of the first time interval in which the third moment is located.

[0057] With reference to the third aspect, in a possible implementation, the processing module is further configured to: set, as the first time interval, a time interval at which the network node collects statistics about the congestion status.

[0058] With reference to the third aspect, in a possible implementation, the receiving module is further configured to: receive a setting packet, where the setting packet is used to indicate a time interval at which the network node collects statistics about the congestion status, and the setting packet includes the first time interval; and the processing module is further configured to: set, as the first time interval based on the setting packet, the time interval at which the network node collects statistics about the congestion status.

[0059] With reference to the third aspect, in a possible implementation, the processing module is further configured to: set, as the first time interval based on a communication protocol, the time interval at which the network node collects statistics about the congestion status.

[0060] With reference to the third aspect, in a possible implementation, the sending module is further configured to: send an acknowledgment packet, where the acknowledgment packet is used to indicate that the network node has set the time interval at which the network node collects statistics about the congestion status.

[0061] According to a fourth aspect, a network node is provided. The network node includes a first network node and a second network node, the network node is the second network node, and the network node includes: a sending module, configured to send a first delimitation packet at a second moment, where the first delimitation packet includes a first identifier, and the first identifier is used to indicate the moment at which the network node sends the first delimitation packet, where the sending module is further configured to send a second delimitation packet at a fourth moment, the second delimitation packet includes a second identifier, the second identifier is used to indicate a moment at which the network node sends the second delimitation packet, the second delimitation packet and the first delimitation packet are two neighboring delimitation packets, and a time interval between the fourth moment and the second moment is equal to a first time interval; a processing module, configured to collect statistics about first data based on the first delimitation packet and the second delimitation packet, where the first data is used to indicate a congestion status in the first time interval between the second moment and the fourth moment; and

a receiving module, configured to receive, by using the first time interval as a periodicity, a first-type statistics packet sent by the first network node, where the first-type statistics packet includes the first identifier, and the first-type statistics packet is used to indicate a congestion status of the first network node in the first time interval, where the processing module is further configured to obtain a first congestion degree based on the first data and the first-type statistics packet, and the first congestion degree is used to indicate a congestion degree in the first time interval.

[0062] With reference to the fourth aspect, in a possible implementation, the first-type statistics packet includes a first receiving rate of the first network node in the first time interval.

[0063] With reference to the fourth aspect, in a possible implementation, the first-type statistics packet includes a third identifier, a fourth identifier, and a quantity of data packets that are received by the first network node, where statistics about the quantity of data packets are collected by the first network node, the third identifier is used to indicate a moment at which the first network node receives the first delimitation packet, and the fourth identifier is used to indicate a moment at which the first network node sends the first-type statistics packet.

[0064] With reference to the fourth aspect, in a possible implementation, the first identifier includes a second moment, and the second moment is a moment at which the second network node sends the first delimitation packet.

[0065] With reference to the fourth aspect, in a possible implementation, the second identifier includes a fourth moment, and the fourth moment is a moment at which the second network node sends the second delimitation packet.

[0066] With reference to the fourth aspect, in a possible implementation, the first data is a first sending rate of the network node in the first time interval between the second moment and the fourth moment; or the first data is a quantity of data packets that are sent by the network node in the first time interval between the second moment and the fourth moment.

[0067] With reference to the fourth aspect, in a possible implementation, the receiving module is further configured to: receive a second-type statistics packet, where the second-type statistics packet includes the first identifier, the second-type statistics packet is used to indicate a congestion status of the first network node in a time interval between a third moment and a start moment of the first time interval in which the third moment is located, and the third moment is a moment at which the first network node receives the second delimitation packet; and the processing module is further configured to: obtain a second congestion degree based on the first data and the second-type statistics packet, where the second congestion degree is used to indicate a congestion degree in the time interval between the third moment and the start moment of the first time interval in which the third moment is located.

[0068] With reference to the fourth aspect, in a possible implementation, the second-type statistics packet includes a second receiving rate of the first network node in the time interval between the third moment and the start moment of the first time interval in which the third moment is located.

[0069] With reference to the fourth aspect, in a possible implementation, the second-type statistics packet includes a fifth identifier, a sixth identifier, and the quantity of data packets that are received by the first network node, where statistics about the quantity of data packets are collected by the first network node, the fifth identifier is used to indicate the start moment of the first time interval in which the third moment is located, and the sixth identifier is used to indicate the third moment.

[0070] With reference to the fourth aspect, in a possible implementation, the receiving module is further configured to: receive a third-type statistics packet, where the third-type statistics packet includes the second identifier, and the third-type statistics packet is used to indicate a congestion status of the first network node in a time interval between the third moment and an end moment of the first time interval in which the third moment is located; and the processing module is further configured to: collect statistics about second data, where the second data is used to indicate a congestion status in the first time interval between a fourth moment and a fifth moment, a time interval between the fifth moment and the fourth moment is the first time interval, and the fifth moment is later than the fourth moment; obtain a third congestion degree based on the second data and the third-type statistics packet, where the third congestion degree is used to indicate a congestion degree in the time interval between the third moment and the end moment of the first time interval in which the third moment is located; and obtain a fourth congestion degree based on the second congestion degree and the third congestion degree, where the fourth congestion degree is used to indicate a congestion degree in the first time interval in which the third moment is located.

[0071] With reference to the fourth aspect, in a possible implementation, the processing module is further configured to: determine an average value of the second congestion degree and the third congestion degree as the fourth congestion degree.

[0072] With reference to the fourth aspect, in a possible implementation, the second data is a second sending rate in the time interval between the fourth moment and the fifth moment; or the second data is a quantity of data packets that are sent by the network node in the time interval between the fourth moment and the fifth moment.

[0073] With reference to the fourth aspect, in a possible implementation, the third-type statistics packet includes a third receiving rate of the first network node in the time interval between the third moment and the end moment of the first time interval in which the third moment is located.

[0074] With reference to the fourth aspect, in a possible

implementation, the third-type statistics packet includes the sixth identifier, a seventh identifier, and the quantity of data packets that are received by the first network node, where statistics about the quantity of data packets are collected by the first network node, and the seventh identifier is used to indicate the end moment of the first time interval in which the third moment is located.

[0075] With reference to the fourth aspect, in a possible implementation, the sending module is further configured to: send a setting packet, where the setting packet is used to indicate a time interval at which the first network node collects statistics about the congestion status, and the setting packet includes the first time interval.

[0076] With reference to the fourth aspect, in a possible implementation, the receiving module is further configured to: receive an acknowledgment packet, where the acknowledgment packet is used to indicate that the first network node has set the time interval at which the first network node collects statistics about the congestion status.

[0077] According to a fifth aspect, a network node is provided. The network node includes a transceiver, a processor, and a memory. The processor is configured to control the transceiver to receive and send a signal. The memory is configured to store a computer program. The processor is configured to invoke the computer program from the memory and run the computer program, so that the network node performs the method in any one of the first aspect or the possible implementations of the first aspect.

[0078] In a design, the network node is a communication chip, the receiving module may be an input circuit or an interface of the communication chip, and the sending module may be an output circuit or an interface of the communication chip.

[0079] According to a sixth aspect, a network node is provided. The network node includes a transceiver, a processor, and a memory. The processor is configured to control the transceiver to receive and send a signal. The memory is configured to store a computer program. The processor is configured to invoke the computer program from the memory and run the computer program, so that the network node performs the method in any one of the second aspect or the possible implementations of the second aspect.

[0080] In a design, the network node is a communication chip, the receiving module may be an input circuit or an interface of the communication chip, and the sending module may be an output circuit or an interface of the communication chip.

[0081] According to a seventh aspect, a network system is provided. The network system includes the network node according to any one of the third aspect or the possible implementations of the third aspect and the network node according to any one of the fourth aspect or the possible implementations of the fourth aspect.

[0082] According to an eighth aspect, a computer program product including instructions is provided. When

the computer program product runs on a computer, the computer is enabled to perform the methods according to the foregoing aspects.

[0083] According to a ninth aspect, a computer-readable storage medium is provided. The computer-readable storage medium stores instructions. When the instructions are run on a computer, the computer is enabled to perform the method according to the foregoing aspects.

BRIEF DESCRIPTION OF DRAWINGS

[0084]

FIG. 1 is a schematic diagram of forwarding an SRv6 packet;

FIG. 2 is a schematic diagram of a moment at which two network nodes send a packet on a single path;

FIG. 3 is a schematic flowchart of a congestion measurement method 300 according to an embodiment of this application;

FIG. 4 shows a form of a setting packet according to an embodiment of this application;

FIG. 5 shows a form of an acknowledgment packet according to an embodiment of this application;

FIG. 6 shows a form of a statistics packet according to an embodiment of this application;

FIG. 7 is a schematic diagram of moments at which a network node sends a delimitation packet and generates a statistics packet according to an embodiment of this application;

FIG. 8 is a schematic diagram of moments at which another network node sends a delimitation packet and generates a statistics packet according to an embodiment of this application;

FIG. 9 is a schematic block diagram of a network node according to an embodiment of this application; FIG. 10 is another schematic block diagram of a network node according to an embodiment of this application;

FIG. 11 is a schematic block diagram of a network node according to an embodiment of this application; FIG. 12 is another schematic block diagram of a network node according to an embodiment of this application; and

FIG. 13 is a schematic block diagram of a network system according to an embodiment of this application.

DESCRIPTION OF EMBODIMENTS

[0085] For ease of understanding of embodiments of this application, the following descriptions are first provided before the embodiments of this application are described.

[0086] First, in the embodiments of this application, an "indication" may include a direct indication and an indirect indication, or may include an explicit indication and an

implicit indication. Information indicated by a piece of information (for example, first indication information described below) is referred to as to-be-indicated information. In a specific implementation process, the to-be-indicated information may be indicated in a plurality of manners, for example, but not limited to, a manner of directly indicating the to-be-indicated information. For example, the to-be-indicated information is indicated by using the to-be-indicated information or an index of the to-be-indicated information. Alternatively, the to-be-indicated information may be indirectly indicated by indicating other information, and there is an association relationship between the other information and the to-be-indicated information. Alternatively, only a part of the to-be-indicated information may be indicated, and the other part of the to-be-indicated information is already known or pre-agreed on. For example, specific information may alternatively be indicated by using an arrangement sequence of a plurality of pieces of information that is pre-agreed on (for example, stipulated in a protocol), to reduce indication overheads to some extent.

[0087] Second, the terms "first", "second", and various numbers in the following embodiments are merely used for differentiation for ease of description, and are not used to limit the scope of the embodiments of this application. For example, the terms are used to distinguish between different packets.

[0088] Third, "protocol" in the embodiments of this application may be a standard protocol in the communication field, for example, including an LTE protocol, an NR protocol, and a related protocol applied to a future communication system. This is not limited in this application.

[0089] Fourth, "a plurality of" in the embodiments of this application means two or more. "One or more of the following items (pieces)" or a similar expression thereof refers to any combination of these items, including any combination of singular items (pieces) or plural items (pieces). For example, "at least one or more of a, b, and c" may indicate a, b, c, a and b, a and c, b and c, or a, b, and c, where a, b, and c may be singular or plural.

[0090] Fifth, the "timestamp" in the embodiments of this application is at least accurate to milliseconds. In other words, the "timestamp" may be \times year \times month \times day \times hour \times minute \times second \times millisecond, for example, 2019-05-27 08:10:5:1. Alternatively, the "timestamp" may be \times year \times month \times day \times hour \times minute \times second \times millisecond \times microsecond, for example, 2019-05-28 13:10:8:5:10.

[0091] Sixth, the "moment" in the embodiments of this application is at least accurate to milliseconds. In other words, the "moment" may be \times year \times month \times day \times hour \times minute \times second \times millisecond, for example, 2019-05-29 06:50:22:1. Alternatively, the "moment" may be \times year \times month \times day \times hour \times minute \times second \times millisecond \times microsecond, for example, 2019-05-30 13:46:9:5:10.

[0092] The following describes technical solutions in this application with reference to the accompanying

drawings.

[0093] FIG. 1 is a schematic diagram of forwarding an SRv6 packet. A network 100 shown in FIG. 1 includes nodes 101 to 116, an enterprise 117, a home broadband 118, and a base station 119. The node may be a router device. The enterprise 117, the home broadband 118, and the base station 119 are separately connected to corresponding nodes, to implement packet forwarding.

[0094] FIG. 2 is a schematic diagram of a moment at which two network nodes send a packet on a single path. A second network node may be a source (which may be understood as a transmit end), and a first network node may be a sink (which may be understood as a receive end). The second network node continuously sends measurement packets to the first network node at an equal time interval t_i . For example, the second network node sends four measurement packets. The second network node sends a first measurement packet at a moment t_0 , and the first network node receives the first measurement packet at a moment t_1 . The second network node sends a second measurement packet at a moment t_3 , and the first network node receives the second measurement packet at a moment t_4 . The second network node sends a third measurement packet at a moment t_5 , and the first network node receives the third measurement packet at a moment t_6 . The second network node sends a fourth measurement packet at a moment t_7 , and the first network node receives the fourth measurement packet at a moment t_8 . A time interval between t_0 and t_3 is t_i , a time interval between t_3 and t_5 is t_i , and a time interval between t_5 and t_7 is t_i . The first network node generates a first statistics packet corresponding to the first measurement packet in a time interval between t_1 and t_4 . The first network node generates a second statistics packet corresponding to the second measurement packet in a time interval between t_4 and t_6 . The first network node generates a third statistics packet corresponding to the third measurement packet in a time interval between t_6 and t_8 . Because congestion statuses of paths continuously change, the time interval between t_1 and t_4 , the time interval between t_4 and t_6 , and the time interval between t_6 and t_8 may not be equal. Therefore, congestion measurement cannot be performed in real time, and adjustment requirements on a data plane cannot be met.

[0095] Therefore, it is urgent to provide a method that can meet adjustment requirements on a data plane.

[0096] The following describes in detail the method provided in the embodiments of this application with reference to the accompanying drawings.

[0097] In the following shown embodiments, optionally, the first network node and the second network node may be router devices.

[0098] In the following, the embodiments of this application are described in detail by using an example of interaction between the first network node and the second network node. FIG. 3 is a schematic flowchart of a congestion measurement method 300 according to an

embodiment of this application from a perspective of interaction between the first network node and the second network node. As shown in FIG. 3, the method 300 may include step 310 to step 280. The following describes the steps in the method 300 in detail.

[0099] The method is performed in a communication system including the first network node and the second network node. The method may be used in congestion measurement of one path between the first network node and the second network node. The path may be understood as any of a plurality of paths configured for one tunnel between the first network node and the second network node.

[0100] Step 310: The first network node sets, as a first time interval, a time interval at which the first network node collects statistics about a congestion status.

[0101] The first time interval is a time interval at which the second network node sends two neighboring delimitation packets.

[0102] In network measurement, a data packet is used as an observation sample, and two measurement packets are inserted into data traffic to bound a scope of the observation sample. The two measurement packets are delimitation packets. The delimitation packets are used to indicate that a time period in which the second network node collects statistics about the congestion status corresponds to a time period in which the first network node collects statistics about the congestion status.

[0103] For example, as shown in FIG. 2, the second network node sends a 1st delimitation packet at a moment t_0 , and the second network node sends a 2nd delimitation packet at a moment t_7 . The first network node receives the 1st delimitation packet at a moment t_1 , and the first network node receives the 2nd delimitation packet at a moment t_8 . A data packet used by the second network node as an observation sample is a data packet sent by the second network node in a time interval between the moment t_0 and the moment t_7 . Correspondingly, a data packet that is used by the first network node as an observation sample and that corresponds to the data packet used by the second network node as an observation sample is a data packet received by the first network node in a time interval between the moment t_1 and the moment t_8 .

[0104] The delimitation packet may be understood as a protocol packet. The delimitation packet may also be understood as a packet formed after a data packet is colored and is different from the data packet. When receiving a packet, the first network node may determine, by using a packet type indicated in a field in the packet, whether the received packet is a delimitation packet, a data packet, or a packet of another type.

[0105] The first network node may set, in the following two manners, the time interval at which the first network node collects statistics about the congestion status.

Manner 1

[0106] The first network node receives a setting packet

sent by the second network node. The setting packet is used to indicate the time interval at which the first network node collects statistics about the congestion status, and the setting packet includes the first time interval.

[0107] That the setting packet includes the first time interval may be understood as that the time interval that is indicated in the setting packet and at which the first network node collects statistics about the congestion status is the first time interval.

[0108] The first network node sets, as the first time interval based on the setting packet, the time interval at which the first network node collects statistics about the congestion status. For example, the first time interval included in the setting packet may be 0.5 ms, and the first network node sets, as 0.5 ms based on the setting packet, the time interval at which the first network node collects statistics about the congestion status. For another example, the first time interval included in the setting packet may be 1 ms, and the first network node sets, as 1 ms based on the setting packet, the time interval at which the first network node collects statistics about the congestion status.

[0109] Optionally, that the first network node collects statistics about the congestion status at the time interval may be understood as that the first network node collects statistics about the congestion status of the first network node once every time interval. For example, when the first time interval is 0.5 ms, the first network node collects statistics about the congestion status of the first network node once every 0.5 ms. For another example, when the first time interval is 1 ms, the first network node collects statistics about the congestion status of the first network node once every 1 ms.

[0110] For example, a form of the setting packet may be shown in FIG. 4. The setting packet may include a packet type (Control Code) field, a tunnel identifier (Session id) path identifier (Path ID) field, and a statistics collection interval time (Interval time) field. In the packet type field, when the packet type field indicates 0, the packet is a setting packet; and when the packet type field indicates 1, the packet is an acknowledgment packet. The tunnel identifier path identifier field indicates an identifier of a tunnel path that needs to be measured. The statistics collection interval time field indicates a time interval (for example, the first time interval) at which the first network node performs statistics collection, a statistics collection interval time may occupy 16 bits, a unit of the statistics collection interval time is milliseconds (ms), and the packet type field indicates 0. The setting packet may further include two reserved (Reserve) fields.

Manner 2

[0111] The time interval at which the first network node collects statistics about the congestion status is stipulated in a communication protocol, and it is stipulated that the time interval at which the first network node collects statistics about the congestion status is the first time in-

terval.

[0112] The first network node sets, as the first time interval according to stipulations in the communication protocol, the time interval at which the first network node collects statistics about the congestion status. For example, the first time interval stipulated in the communication protocol may be 0.6 ms, and the first network node sets, as 0.6 ms based on the first time interval stipulated in the communication protocol, the time interval at which the first network node collects statistics about the congestion status. For another example, the first time interval stipulated in the communication protocol may be 0.8 ms, and the first network node sets, as 0.8 ms based on the first time interval stipulated in the communication protocol, the time interval at which the first network node collects statistics about the congestion status.

[0113] After the first network node has set the time interval at which the first network node collects statistics about the congestion status, step 320 may be performed.

[0114] Step 320: The second network node receives an acknowledgment packet sent by the first network node, where the acknowledgment packet is used to indicate that the first network node has set the time interval at which the first network node collects statistics about the congestion status.

[0115] For example, a form of the acknowledgment packet may be shown in FIG. 5. The acknowledgment packet may include a packet type field, a tunnel identifier path identifier field, a statistics collection interval time field, and an accept (Accept) field, and the acknowledgment packet may further include a reserved field. The accept field is used to indicate a setting result part in the acknowledgment packet. If the first network node succeeds in setting based on the setting packet, the accept field indicates 0. If the first network node fails in setting based on the setting packet, the accept field indicates 1, and the packet type field indicates 1.

[0116] When the accept field in the acknowledgment packet indicates 0, the second network node starts to perform a measurement operation, that is, perform step 330.

[0117] Step 330: The second network node sends a first delimitation packet, where the first delimitation packet includes a first identifier, and the first identifier is used to indicate a moment at which the second network node sends the first delimitation packet. Correspondingly, the first network node receives the first delimitation packet.

[0118] Optionally, the moment at which the second network node sends the first delimitation packet may be a second moment, and a moment at which the first network node receives the first delimitation packet is a first moment. The first moment is later than the second moment. That the first identifier is used to indicate the moment at which the second network node sends the first delimitation packet may be understood as that the first identifier is used to indicate the second moment.

[0119] Optionally, when sending the first delimitation packet, the second network node records the first identifier,

includes the first identifier in the first delimitation packet, and sends the first delimitation packet to the first network node.

[0120] Optionally, the first identifier may be a first timestamp. The first timestamp is used to indicate the moment at which the second network node sends the first delimitation packet, that is, the first timestamp is used to indicate the second moment.

[0121] For example, as shown in FIG. 7, the second network node sends the first delimitation packet at a moment t_0 , and the first network node receives the first delimitation packet at a moment t_1 . Therefore, the second moment may be the moment t_0 , the first moment may be the moment t_1 , and the moment t_0 is earlier than the moment t_1 .

[0122] Optionally, after receiving the first delimitation packet, the first network node records a third identifier. The third identifier is used to indicate the moment at which the first network node receives the first delimitation packet, that is, the first moment.

[0123] The third identifier may be a third timestamp. The third timestamp is used to indicate the moment at which the first network node receives the first delimitation packet. In other words, the third timestamp is the first moment.

[0124] Step 340: The first network node collects, based on the first delimitation packet, statistics about the congestion status of the first network node in the first time interval by using the first time interval as a periodicity, where the first time interval is a time interval at which the second network node sends two neighboring delimitation packets.

[0125] Optionally, when starting to collect statistics about the congestion status in the first time interval, the first network node records an identifier. The identifier is used to indicate a moment at which the first network node starts statistics collection. The identifier may be a timestamp.

[0126] Optionally, that the first network node collects, based on the first delimitation packet, statistics about the congestion status of the first network node in the first time interval by using the first time interval as a periodicity may be understood as that after receiving the first delimitation packet, the first network node collects statistics about the congestion status of the first network node in a corresponding first time interval once every first time interval.

[0127] For example, as shown in FIG. 7, the first network node receives the first delimitation packet at the moment t_1 , and collects statistics about the congestion status in the first time interval based on the first delimitation packet. The first time interval is t_i , that is, the first network node collects statistics about the congestion status of the first network node once every first time interval t_i starting from the moment t_1 .

[0128] The congestion status of the first network node in the first time interval may be understood as a receiving rate of the first network node in the first time interval.

Alternatively, the congestion status of the first network node in the first time interval may be understood as a quantity of data packets that are received by the first network node in the first time interval.

[0129] Step 350: The second network node sends a second delimitation packet, where the second delimitation packet includes a second identifier, and the second identifier is used to indicate a moment at which the second network node sends the second delimitation packet; the second delimitation packet and the first delimitation packet are two neighboring delimitation packets; and a time interval at which the second network node sends the two neighboring delimitation packets is the first time interval. Correspondingly, the first network node receives the second delimitation packet at a third moment. A time interval between the third moment and the first moment is greater than the first time interval, and the first moment is the moment at which the first network node receives the first delimitation packet.

[0130] Optionally, when sending the second delimitation packet, the second network node records the second identifier, includes the second identifier in the second delimitation packet, and sends the second delimitation packet to the first network node.

[0131] Optionally, the moment at which the second network node sends the second delimitation packet may be a fourth moment.

[0132] Optionally, the second identifier may be a second timestamp. The second timestamp is used to indicate the moment at which the second network node sends the second delimitation packet, that is, the second timestamp is used to indicate the fourth moment.

[0133] That the second delimitation packet and the first delimitation packet are two neighboring delimitation packets may be understood as that the second network node respectively sends the first delimitation packet and the second delimitation packet to the first network node at moments whose difference is the first time interval, and the second network node does not send another delimitation packet in the first time interval; or that the second delimitation packet and the first delimitation packet are two neighboring delimitation packets may be understood as that the first network node respectively receives, at moments whose difference is the first time interval, the first delimitation packet and the second delimitation packet that are sent by the second network node, and the first network node does not receive another delimitation packet in the first time interval.

[0134] For example, as shown in FIG. 7, the second network node sends the first delimitation packet at the moment t_0 , and the first network node receives the first delimitation packet at the moment t_1 . The second network node sends the second delimitation packet at a moment t_3 , and the first network node receives the second delimitation packet at a moment t_4 . The fourth moment may be the moment t_3 , the third moment may be the moment t_4 , the moment t_3 is earlier than the moment t_4 , the first time interval is t_1 , and a time interval between the moment

t_1 and the moment t_4 is greater than t_1 .

[0135] Step 360: The first network node sends a first-type statistics packet to the second network node by using the first time interval as a periodicity, where the first-type statistics packet includes the first identifier, and the first-type statistics packet is used to indicate the congestion status of the first network node in the first time interval. Correspondingly, the second network node receives, by using the first time interval as a periodicity, the first-type statistics packet sent by the first network node.

[0136] Optionally, that the first network node sends a first-type statistics packet to the second network node by using the first time interval as a periodicity may be understood as that the first network node sends the first-type statistics packet to the second network node by using the first moment as a start moment and by using the first time interval as a periodicity. In other words, a moment at which the first network node sends the first-type statistics packet may be $T_i = t_1 + Nt_i$. t_1 is the moment at which the first network node receives the first delimitation packet, that is, the first moment, N is a positive integer, and t_i is the first time interval.

[0137] For example, a form of the statistics packet is shown in FIG. 6. The statistics packet may include two parts: a packet header (Header) and data (Data). The packet header may include a tunnel identifier path identifier field, a data-area-stored data type (Path-E2E-Type) field, a packet type (Flags) field, and a transaction number (Transaction ID) field. The tunnel identifier path identifier field is used to indicate an identifier of a path about which the first network node collects statistics. In the data-area-stored data type field, for example, data-area-stored data may be a timestamp and/or a quantity of packets. The timestamp may be indicated by using Bit 0, and the timestamp may be understood as two moments, that is, a start moment and an end moment. The quantity of packets may be indicated by using Bit 1, and the quantity of packets may be a quantity of packets between the start moment and the end moment. The data-area-stored data type field may store a plurality of fields. In the packet type (Flags) field, when the packet type field is indicated by using Bit 0, the type of a packet is a statistics packet. When the packet type field is indicated by using Bit 1, the type of a packet is a result packet, and other fields are temporarily reserved. One transaction number is generated each time statistics are collected. The transaction number may be understood as for which time statistics are collected. In the data part, a data type indicated by the data-area-stored data type may be a timestamp and/or a quantity of packets, for example, may be the first moment, the second moment, or a quantity of packets that are received by the first network node in a time interval between the first moment and a moment at which the first network node sends a statistics packet.

[0138] Optionally, the first-type statistics packet includes a first receiving rate of the first network node in the first time interval. Alternatively, the first-type statistics packet includes the third identifier, a fourth identifier, and

a quantity of data packets that are received by the first network node, where statistics about the quantity of data packets are collected by the first network node, the third identifier is used to indicate the moment at which the first network node receives the first delimitation packet, and the fourth identifier is used to indicate a moment at which the first network node sends the first-type statistics packet.

[0139] The quantity, included in the first-type statistics packet, of the data packets that are received by the first network node may be understood as a quantity of data packets that are received by the first network node in a time interval between the first moment and the moment at which the first network node sends the first-type statistics packet.

[0140] Optionally, when sending the first-type statistics packet, the first network node records the fourth identifier and includes the fourth identifier in the first-type statistics packet. The first network node also includes the first identifier in the first delimitation packet and the third identifier recorded in the first network node together in the first-type statistics packet, and sends the first-type statistics packet to the second network node.

[0141] Optionally, the fourth identifier may be a fourth timestamp. The fourth timestamp is used to indicate the moment at which the first network node sends the first-type statistics packet.

[0142] Optionally, the fourth identifier includes the moment at which the first network node sends the first-type statistics packet.

[0143] As shown in FIG. 8, the second network node sends a first delimitation packet at a moment t_0 , and sends a second delimitation packet at a moment t_3 . A time interval between the moment t_0 and the moment t_3 is a first time interval t_i . The first network node receives the first delimitation packet at a moment t_1 , and receives the second delimitation packet at a moment t_4 . A time interval between the moment t_1 and the moment t_4 is two first time intervals. For example, the first-type statistics packet may include a first receiving rate of the first network node in the time interval t_i between the moment t_1 and a moment $t_2 ((t_1 + t_i))$; or the first-type statistics packet includes the moment t_0 , the moment t_1 , the moment t_2 , and a quantity of data packets that are received by the first network node in a time interval (a 1st t_i) between the moment t_1 and the moment t_2 . For another example, the first-type statistics packet may further include a first receiving rate of the first network node in the time interval t_i between the moment t_2 and a moment $t_4 ((t_2 + 2t_i))$; or the first-type statistics packet includes the moment t_3 , the moment t_2 , the moment t_4 , and a quantity of data packets that are received by the first network node in a time interval (a 2nd t_i) between the moment t_2 and the moment t_4 .

[0144] Step 370: The second network node collects statistics about first data based on the first delimitation packet and the second delimitation packet, where the first data is used to indicate a congestion status in the

first time interval.

[0145] Optionally, the first data may be a first sending rate in a time interval between the second moment and the fourth moment; or the first data is a quantity of data packets that are sent by the second network node in the time interval between the second moment and the fourth moment.

[0146] As shown in FIG. 8, the second network node sends the first delimitation packet at the moment t_0 , and the second network node sends the second delimitation packet at the moment t_3 . In other words, the second moment is the moment t_0 , and the fourth moment is the moment t_3 . The first data is the congestion status of the second network node in the first time interval t_i between the moment t_0 and the moment t_3 . The first data may be a first sending rate of the second network node in the first time interval t_i between the moment t_0 and the moment t_3 ; or the first data may be a quantity of data packets that are sent by the second network node in the first time interval t_i between the moment t_0 and the moment t_3 .

[0147] Optionally, a time interval between the moment at which the first network node receives the first delimitation packet and the moment at which the first network node receives the second delimitation packet may be an integer multiple of the first time interval. For example, as shown in FIG. 8, the time interval between the moment at which the first network node receives the first delimitation packet and the moment at which the first network node receives the second delimitation packet is twice the first time interval. The time interval between the moment at which the first network node receives the first delimitation packet and the moment at which the first network node receives the second delimitation packet may not be an integer multiple of the first time interval. For example, as shown in FIG. 7, the time interval between the moment at which the first network node receives the first delimitation packet and the moment at which the first network node receives the second delimitation packet is 1.8 times the first time interval. This is not limited in this application.

[0148] Step 380: The second network node obtains a first congestion degree based on the first data and the first-type statistics packet, where the first congestion degree is used to indicate a congestion degree in the first time interval.

[0149] Optionally, after receiving the first-type statistics packet, the second network node may determine, based on the first identifier in the first-type statistics packet, that the first-type statistics packet sent by the first network node corresponds to the first data about which the second network node collects statistics. In other words, the second network node needs to obtain the first congestion degree based on the first data and the first-type statistics packet. The first congestion degree is used to indicate the congestion degree in the first time interval.

[0150] For example, as shown in FIG. 8, the first congestion degree may be a congestion degree of a corresponding path in the time interval between the moment

t_1 and the moment t_2 . For another example, as shown in FIG. 8, the first congestion degree may be a congestion degree of a corresponding path in the time interval between the moment t_2 and the moment t_4 .

[0151] Optionally, the second network node may obtain a first congestion degree J_1 based on the following formula:

$$J_1 = \frac{\frac{a}{t_i}}{\frac{b}{t_i}}$$

where a is the quantity of data packets that are received by the first network node in the first time interval, b is the quantity of data packets that are sent by the second network node in the time interval between the second moment and the fourth moment, and t_i is the first time interval.

[0152] For example, as shown in FIG. 8, a may be a quantity of data packets that are received by the first network node in the time interval between the moment t_1 and the moment t_2 ; or a may be a quantity of data packets that are received by the first network node in the time interval between the moment t_2 and the moment t_4 .

[0153] For example, as shown in FIG. 8, b may be a quantity of data packets that are sent by the second network node in the time interval between the moment t_0 and the moment t_3 .

[0154] Optionally, the second network node may obtain a first congestion degree J_1 based on the following formula:

$$J_1 = \frac{v_1}{v_2}$$

where v_1 is the first receiving rate of the first network node in the first time interval, and v_2 is the first sending rate of the second network node in the time interval between the second moment and the fourth moment.

[0155] For example, as shown in FIG. 8, v_1 may be the first receiving rate of the first network node in the time interval between the moment t_1 and the moment t_2 ; or a may be the first receiving rate of the first network node in the time interval between the moment t_2 and the moment t_4 .

[0156] For example, as shown in FIG. 8, v_2 may be the first sending rate of the second network node in the time interval between the moment t_0 and the moment t_3 .

[0157] Optionally, when the third moment and a start moment or an end moment of the first time interval do not overlap, the second network node further needs to perform step 381 to step 386. For example, as shown in FIG. 7, the first moment may be t_1 , the second moment may be t_0 , the third moment may be t_3 , and the fourth

moment may be t_4 . When t_4 and an end moment of 2nd t_i after the moment t_1 at which the first network node receives the first delimitation packet do not overlap, step 381 to step 386 further need to be performed.

5 [0158] Step 381: The second network node receives a second-type statistics packet sent by the first network node, where the second-type statistics packet includes the first identifier, and the second-type statistics packet is used to indicate a congestion status of the first network node in a time interval between the third moment and the start moment of the first time interval in which the third moment is located. Correspondingly, the first network node sends the second-type statistics packet to the second network node at the third moment.

10 [0159] Optionally, the second-type statistics packet includes a second receiving rate of the first network node in the time interval between the third moment and the start moment of the first time interval in which the third moment is located. Alternatively, the second-type statistics packet includes a fifth identifier, a sixth identifier, and the quantity of data packets that are received by the first network node, where statistics about the quantity of data packets are collected by the first network node, the fifth identifier is used to indicate the start moment of the first time interval in which the third moment is located, the sixth identifier is used to indicate the third moment, and the third moment is the moment at which the first network node receives the second delimitation packet.

15 [0160] Optionally, when sending the second-type statistics packet, the first network node records the sixth identifier and includes the sixth identifier in the second-type statistics packet. The first network node also includes the first identifier in the first delimitation packet and the fifth identifier recorded in the first network node together in the first-type statistics packet, and sends the first-type statistics packet to the second network node.

20 [0161] Optionally, the fifth identifier may be a fifth timestamp. The fifth timestamp is used to indicate the start moment of the first time interval in which third moment is located.

25 [0162] Optionally, the sixth identifier may be a sixth timestamp. The sixth timestamp is used to indicate the third moment.

30 [0163] For example, as shown in FIG. 7, the second network node sends the first delimitation packet at the moment t_0 , and sends the second delimitation packet at the moment t_3 . The time interval between the moment t_0 and the moment t_3 is the first time interval t_i . The first network node receives the first delimitation packet at the moment t_1 and receives the second delimitation packet at the moment t_4 . The time interval between the moment t_1 and the moment t_4 is 1.8 times the first time interval. In other words, the moment t_4 and an end moment (a moment t_5) of a 2nd first time interval do not overlap, and the first network node needs to send the second-type statistics packet to the second network node at the moment t_4 . The second-type statistics packet includes the second receiving rate of the first network node in a time

interval between a moment t_2 and the moment t_4 ; or the second-type statistics packet includes the moment t_0 , the moment t_2 , the moment t_4 , and the quantity of data packets that are received by the first network node in the time interval between the moment t_2 and the moment t_4 , where statistics about the quantity of data packets are collected by the first network node.

[0164] Step 382: The second network node obtains a second congestion degree based on the first data and the second-type statistics packet, where the second congestion degree is used to indicate a congestion degree in the time interval between the third moment and the start moment of the first time interval in which the third moment is located.

[0165] Optionally, after receiving the second-type statistics packet, the second network node may determine, based on the first identifier in the second-type statistics packet, that the second-type statistics packet sent by the first network node corresponds to the first data about which the second network node collects statistics. In other words, the second network node needs to obtain the second congestion degree based on the first data and the second-type statistics packet.

[0166] As shown in FIG. 7, the second congestion degree may be a congestion degree of a corresponding path in the time interval between the moment t_2 and the moment t_4 .

[0167] Optionally, the second network node may obtain a second congestion degree J_2 based on the following formula:

$$J_2 = \frac{\frac{c}{\Delta t}}{\frac{b}{t_i}}$$

where c is a quantity of data packets that are received by the first network node in the time interval between the third moment and the start moment of the first time interval in which the third moment is located, and Δt is the time interval between the third moment and the start moment of the first time interval in which the third moment is located.

[0168] For example, as shown in FIG. 7, c may be a quantity of data packets that are received by the first network node in the time interval between the moment t_2 and the moment t_4 .

[0169] For example, as shown in FIG. 7, Δt may be the time interval between the moment t_2 and the moment t_4 .

[0170] Optionally, the second network node may obtain a second congestion degree J_2 based on the following formula:

$$J_1 = \frac{v_{11}}{v_2}$$

where v_{11} is the second receiving rate of the first network node in the time interval between the third moment and the start moment of the first time interval in which the third moment is located.

[0171] For example, as shown in FIG. 7, v_{11} may be the second receiving rate of the first network node in the time interval between the moment t_2 and the moment t_4 .

[0172] Step 383: The second network node receives a third-type statistics packet that is sent by the first network node at the end moment of the first time interval in which the third moment is located, where the third-type statistics packet includes the second identifier, and the third-type statistics packet is used to indicate the congestion status of the first network node in the time interval between the third moment and the end moment of the first time interval in which the third moment is located. Correspondingly, the first network node collects statistics about the congestion status in the time interval between the third moment and the end moment of the first time interval in which the third moment is located, and sends the third-type statistics packet to the second network node at the end moment of the first time interval in which the third moment is located.

[0173] Optionally, the third-type statistics packet includes a third receiving rate of the first network node in the time interval between the third moment and the end moment of the first time interval in which the third moment is located. Alternatively, the third-type statistics packet includes the sixth identifier, a seventh identifier, and the quantity of data packets that are received by the first network node, where statistics about the quantity of data packets are collected by the first network node, and the seventh identifier is used to indicate the end moment of the first time interval in which the third moment is located.

[0174] Optionally, when sending the third-type statistics packet, the first network node records the seventh identifier and includes the seventh identifier in the third-type statistics packet. The first network node also includes the first identifier in the first delimitation packet and the sixth identifier recorded in the first network node together in the third-type statistics packet, and sends the third-type statistics packet to the second network node.

[0175] Optionally, the seventh identifier may be a seventh timestamp. The seventh timestamp is used to indicate the end moment of the first time interval in which third moment is located.

[0176] For example, as shown in FIG. 7, the second network node sends the first delimitation packet at the moment t_0 , and sends the second delimitation packet at the moment t_3 . The time interval between the moment t_0 and the moment t_3 is the first time interval t_i . The first network node receives the first delimitation packet at the moment t_1 and receives the second delimitation packet at the moment t_4 . The time interval between the moment t_1 and the moment t_4 is 1.8 times the first time interval. In other words, the moment t_4 and an end moment (a moment t_5) of a 2nd first time interval do not overlap, and the first network node needs to send the third-type sta-

tistics packet to the second network node at the moment t_5 . The third-type statistics packet includes the third receiving rate of the first network node in the time interval between the moment t_4 and the moment t_5 ; or the third-type statistics packet includes the moment t_3 , the moment t_4 , the moment t_5 , and the quantity of data packets that are received by the first network node in the time interval between the moment t_4 and the moment t_5 , where statistics about the quantity of data packets are collected by the first network node.

[0177] Step 384: The second network node collects statistics about second data, where the second data is used to indicate a congestion status in a time interval between the fourth moment and the fifth moment, the time interval between the fifth moment and the fourth moment is the first time interval, and the fifth moment is later than the fourth moment.

[0178] Optionally, the second data is a second sending rate in the time interval between the fourth moment and the fifth moment; or the second data is a quantity of data packets that are sent by the second network node in the time interval between the fourth moment and the fifth moment.

[0179] As shown in FIG. 7, the second data is a congestion status of the second network node in the first time interval t_i between the moment t_3 and a moment t_6 . The second data may be a first sending rate of the second network node in the first time interval t_i between the moment t_3 and the moment t_6 ; or the first data may be a quantity of data packets that are sent by the second network node in the first time interval t_i between the moment t_3 and the moment t_6 .

[0180] Step 385: The second network node obtains a third congestion degree based on the second data and the third-type statistics packet, where the third congestion degree is used to indicate a congestion degree in the time interval between the third moment and the end moment of the first time interval in which the third moment is located.

[0181] Optionally, after receiving the third-type statistics packet, the second network node may determine, based on the second identifier in the third-type statistics packet, that the third-type statistics packet sent by the first network node corresponds to the second data about which the second network node collects statistics. In other words, the second network node needs to obtain the third congestion degree based on the second data and the third-type statistics packet.

[0182] As shown in FIG. 7, the third congestion degree may be a congestion degree of a corresponding path in the time interval between the moment t_4 and the moment t_5 .

[0183] Optionally, the second network node may obtain a third congestion degree J_3 based on the following formula:

$$J_3 = \frac{\frac{e}{(t_i - \Delta t)}}{\frac{d}{t_i}}$$

where e is a quantity of data packets that are received by the first network node in the time interval between the third moment and the end moment of the first time interval in which the third moment is located, and d is the quantity of data packets that are sent by the second network node in the time interval between the fourth moment and the fifth moment.

[0184] For example, as shown in FIG. 7, e may be a quantity of data packets that are received by the first network node in the time interval between the moment t_4 and the moment t_5 .

[0185] For example, as shown in FIG. 7, d may be a quantity of data packets that are sent by the second network node in the time interval between the moment t_3 and the moment t_6 .

[0186] Optionally, the second network node may obtain a third congestion degree J_3 based on the following formula:

$$J_1 = \frac{v_{12}}{v_{21}}$$

where v_{12} is a third receiving rate of the first network node in the time interval between the third moment and the end moment of the first time interval in which the third moment is located, and v_{21} is a second sending rate of the second network node in the time interval between the fourth moment and the fifth moment.

[0187] For example, as shown in FIG. 7, v_{12} may be the third receiving rate of the first network node in the time interval between the moment t_4 and the moment t_5 .

[0188] For example, as shown in FIG. 7, v_{21} may be the second sending rate of the second network node in the time interval between the moment t_3 and the moment t_6 .

[0189] Step 386: The second network node obtains a fourth congestion degree based on the second congestion degree and the third congestion degree, where the fourth congestion degree is used to indicate a congestion degree in the first time interval in which the third moment is located.

[0190] Optionally, the second network node may determine an average value of the second congestion degree and the third congestion degree as the fourth congestion degree.

[0191] For example, as shown in FIG. 7, the second network node sends a delimitation packet to the first network node at the stipulated first time interval. In other words, the second network node sends the first delimitation packet at the moment t_0 , and the first network node

receives the first delimitation packet at the moment t_1 . The second network node sends the second delimitation packet at the moment t_3 , and the first network node receives the second delimitation packet at the moment t_4 . The second network node sends a third delimitation packet at the moment t_6 , and the first network node receives the third delimitation packet at a moment t_7 . The second network node sends a fourth delimitation packet at a moment t_{10} , and the first network node receives the fourth delimitation packet at a moment t_{11} . A time interval between the moment t_0 and the moment t_3 is the first time interval t_i , a time interval between the moment t_3 and the moment t_6 is the first time interval t_i , and a time interval between the moment t_6 and the moment t_{10} is the first time interval t_i . 1.8 first time intervals t_i are included between the moment t_1 and the moment t_4 , and the second network node determines a final congestion degree between t_1 and t_2 based on a congestion degree between the moment t_1 and the moment t_2 and a congestion degree between the moment t_0 and the moment t_3 . Because 1.8 is not a positive integer, the second network node determines a congestion status in the time interval between the moment t_2 and the moment t_5 in the following manner. First, the first network node needs to send a congestion status of the first network node in the time interval between the moment t_2 and the moment t_4 to the second network node at the moment t_4 . The second network node determines a final congestion status in the time interval between the moment t_2 and the moment t_4 based on a congestion status between the moment t_2 and the moment t_4 and a congestion status of the first network node between the moment t_0 and the moment t_3 . Second, the first network node needs to send the congestion status of the first network node in the time interval between the moment t_4 and the moment t_5 to the second network node at the moment t_5 , and the second network node determines a final congestion status in the time interval between the moment t_4 and the moment t_5 based on a congestion status of the first network node in the time interval between the moment t_4 and the moment t_5 and a congestion status of the second network node between the moment t_3 and the moment t_6 . Finally, the final congestion status in the time interval between the moment t_2 and the moment t_4 and the final congestion status in the time interval between the moment t_4 and the moment t_5 are determined as the congestion status in the time interval between the moment t_2 and the moment t_5 . Therefore, congestion measurement accuracy is improved. In addition, the second network node may obtain a congestion status of a path between the first network node and the second network node at an equal time interval, to meet adjustment requirements on a data plane.

[0192] The method 300 may further include step 390.

[0193] Step 390: The second network node adjusts, based on the determined congestion degrees in the time intervals, traffic proportions shared on a plurality of paths in a tunnel between the first network node and the second

network node.

[0194] It should be understood that sequence numbers of the foregoing processes do not mean an execution sequence in the embodiments of this application. The execution sequence of the processes should be determined based on functions and internal logic of the processes, and should not be construed as any limitation on the implementation processes of the embodiments of this application.

[0195] The congestion measurement method in the embodiments of this application is described in detail above with reference to FIG. 3 to FIG. 8. The apparatus in the embodiments of this application is described in detail below with reference to FIG. 9 to FIG. 12.

[0196] An embodiment of this application provides a network node. The following describes a structure and a function of the network node with reference to FIG. 9. FIG. 9 is a schematic block diagram of a network node 10 according to an embodiment of this application. As shown in FIG. 9, the network node 10 includes a receiver 11 and a transmitter 12. Optionally, the network node 10 further includes a processor 13 and a memory 14. The receiver 11, the transmitter 12, the processor 13, and the memory 14 communicate with each other through an inner connection path, to transfer a control signal and/or a data signal. The memory 14 is configured to store a computer program. The processor 13 is configured to invoke the computer program from the memory 14 and run the computer program, to control the receiver 11 to receive a signal, and control the transmitter 12 to send a signal. When the program stored in the memory 14 is executed by the processor 13, the receiver 11 is configured to receive a first delimitation packet, where the first delimitation packet includes a first identifier, and the first identifier is used to indicate a moment at which a second network node sends the first delimitation packet.

[0197] The processor 13 is configured to collect, based on the first delimitation packet, statistics about a congestion status of a first network node by using a first time interval as a periodicity, where the first time interval is a time interval at which the second network node sends two neighboring delimitation packets.

[0198] The transmitter 12 is configured to send a first-type statistics packet to the second network node by using the first time interval as a periodicity, where the first-type statistics packet includes the first identifier, and the first-type statistics packet is used to indicate the congestion status of the first network node in the first time interval.

[0199] The processor 13 and the memory 14 may be combined into a processing apparatus. The processor 13 is configured to execute program code stored in the memory 14, to implement the foregoing functions. In a specific implementation, the memory 14 may alternatively be integrated into the processor 13, or independent of the processor 13.

[0200] It should be understood that the network node 10 may correspond to the first network node in the con-

gestion measurement method 300 in the network according to the embodiments of the present invention, and the network node 10 may include modules configured to perform the method performed by the first network node in the congestion measurement method 300 in the network in FIG. 3. In addition, the modules in the network node 10 and the foregoing other operations and/or functions are respectively intended to implement corresponding procedures of the congestion measurement method 300 in the network in FIG. 3. For a specific process of the foregoing corresponding steps performed by the units, refer to the foregoing description of the method embodiment in FIG. 3. For brevity, details are not described herein again.

[0201] An embodiment of this application further provides a network node. The following describes a structure and a function of the network node with reference to FIG. 10. FIG. 10 is another schematic block diagram of a network node 20 according to an embodiment of this application. As shown in FIG. 10, the network node 20 includes a receiving module 21, a sending module 22, and a processing module 23.

[0202] The receiving module 21, the sending module 22, and the processing module 23 may be implemented by software or hardware. When the modules are implemented by hardware, the receiving module 21 may be the receiver 11 in FIG. 9, the sending module 22 may be the transmitter 12 in FIG. 9, and the processing module 23 may be the processor 13 in FIG. 9.

[0203] An embodiment of this application further provides another network node. The following describes a structure and a function of the network node with reference to FIG. 11. FIG. 11 is a schematic block diagram of a network node 30 according to an embodiment of this application. As shown in FIG. 11, the network node 30 includes a receiver 31 and a transmitter 32. Optionally, the network node 30 further includes a processor 33 and a memory 34. The receiver 31, the transmitter 32, the processor 33, and the memory 34 communicate with each other through an inner connection path, to transfer a control signal and/or a data signal. The memory 34 is configured to store a computer program. The processor 33 is configured to invoke the computer program from the memory 34 and run the computer program, to control the receiver 31 to receive a signal, and control the transmitter 32 to send a signal. When the program stored in the memory 34 is executed by the processor 33, the transmitter 32 is configured to send a first delimitation packet, where the first delimitation packet includes a first identifier, and the first identifier is used to indicate a moment at which a second network node sends the first delimitation packet.

[0204] The transmitter 32 is further configured to send a second delimitation packet, where the second delimitation packet includes a second identifier, and the second identifier is used to indicate a moment at which the second network node sends the second delimitation packet; the second delimitation packet and the first delimitation

packet are two neighboring delimitation packets; and a time interval at which the second network node sends the two neighboring delimitation packets is a first time interval.

[0205] The processor 33 is configured to collect statistics about first data based on the first delimitation packet and the second delimitation packet, where the first data is used to indicate a congestion status in the first time interval.

[0206] The receiver 31 is configured to receive, by using the first time interval as a periodicity, a first-type statistics packet sent by a first network node, where the first-type statistics packet includes the first identifier, and the first-type statistics packet is used to indicate a congestion status of the first network node in the first time interval.

[0207] The processor 33 is further configured to obtain a first congestion degree based on the first data and the first-type statistics packet, where the first congestion degree is used to indicate a congestion degree in the first time interval.

[0208] The processor 33 and the memory 34 may be integrated into one processing apparatus. The processor 33 is configured to execute program code stored in the memory 34 to implement the foregoing functions. In a specific implementation, the memory 34 may alternatively be integrated into the processor 33, or independent of the processor 33.

[0209] It should be understood that the network node 30 may correspond to the second network node in the congestion measurement method 300 in the network according to the embodiments of the present invention, and the network node 30 may include modules configured to perform the method performed by the second network node in the congestion measurement method 300 in the network in FIG. 3. In addition, the modules in the network node 30 and the foregoing other operations and/or functions are respectively intended to implement corresponding procedures of the congestion measurement method 300 in the network in FIG. 3. For a specific process of the foregoing corresponding steps performed by the units, refer to the foregoing description of the method embodiment in FIG. 3. For brevity, details are not described herein again.

[0210] An embodiment of this application further provides a network node. The following describes a structure and a function of the network node with reference to FIG. 12. FIG. 12 is another schematic block diagram of a network node 40 according to an embodiment of this application. As shown in FIG. 12, the network node 40 includes a receiving module 41 and a sending module 42.

[0211] The receiving module 41 and the sending module 42 may be implemented by software or hardware. When the sending module 42 and the receiving module 41 are implemented by hardware, the receiving module 41 may be the receiver 31 in FIG. 11, and the sending module 42 may be the transmitter 32 in FIG. 11.

[0212] It should be understood that, the processor in the embodiments of this application may be a central

processing unit (central processing unit, CPU), or may be another general-purpose processor, a digital signal processor (digital signal processor, DSP), an application-specific integrated circuit (application-specific integrated circuit, ASIC), a field programmable gate array (field programmable gate array, FPGA) or another programmable logic device, a discrete gate or a transistor logic device, a discrete hardware component, or the like. The general-purpose processor may be a microprocessor, or the processor may be any conventional processor or the like.

[0213] It may be understood that the memory in the embodiments of this application may be a volatile memory or a nonvolatile memory, or may include a volatile memory and a nonvolatile memory. The nonvolatile memory may be a read-only memory (read-only memory, ROM), a programmable read-only memory (programmable ROM, PROM), an erasable programmable read-only memory (erasable PROM, EPROM), an electrically erasable programmable read-only memory (electrically EPROM, EEPROM), or a flash memory. The volatile memory may be a random access memory (random access memory, RAM) that is used as an external buffer. Through an example rather than a limitative description, random access memories (random access memories, RAMs) in many forms may be used, for example, a static random access memory (static RAM, SRAM), a dynamic random access memory (DRAM), a synchronous dynamic random access memory (synchronous DRAM, SDRAM), a double data rate synchronous dynamic random access memory (double data rate SDRAM, DDR SDRAM), an enhanced synchronous dynamic random access memory (enhanced SDRAM, ESDRAM), a synchlink dynamic random access memory (synchlink DRAM, SLDRAM), and a direct rambus random access memory (direct rambus RAM, DR RAM).

[0214] An embodiment of this application further provides a communication system. FIG. 13 is a schematic block diagram of a network device 50 according to an embodiment of this application. As shown in FIG. 13, the network system 50 includes a network node 51 and a network node 52. The network node 51 may be the network node 10 shown in FIG. 9, and the network node 52 may be the network node 30 shown in FIG. 11; or the network node 51 may be the network node 20 shown in FIG. 10, and the network node 52 may be the network node 40 shown in FIG. 12.

[0215] It should be understood that the network node 51 may correspond to the first network node in the congestion measurement method 300 in the network according to the embodiments of the present invention, and the network node 51 may include modules configured to perform the method performed by the first network node in the congestion measurement method 300 in the network in FIG. 3. The network node 52 may correspond to the second network node in the congestion measurement method 300 in the network according to the embodiments of the present invention, and the network node 52 may include modules configured to perform the method per-

formed by the second network node in the congestion measurement method 300 in the network in FIG. 3. In addition, the modules in the network node 51 and the network node 52 and the foregoing other operations and/or functions are respectively intended to implement corresponding procedures of the congestion measurement method 300 in the network in FIG. 3. For a specific process of the foregoing corresponding steps performed by the units, refer to the foregoing description of the method embodiment in FIG. 3. For brevity, details are not described herein again.

[0216] In the network nodes in the foregoing embodiments, for example, the network node 51 and the network node 52, each network node is divided into a data plane and a control plane, where a connection is established between control planes of the network nodes. The control plane is mainly responsible for negotiating measurement capabilities and measurement parameters (for example, a time interval for collecting statistics about a congestion status). The data plane is mainly responsible for sending and receiving measurement packets, returning measurement results (for example, a statistics packet), and the like, and performing actual measurement to form a connection between data planes. For example, in the method 300, a data plane of the first network node is connected to a data plane of the second network node. When the data plane of the first network node is connected to the data plane of the second network node, the data plane of the second network node is mainly responsible for sending a measurement packet (for example, a first measurement packet) to the first network node. Correspondingly, the data plane of the first network node receives the measurement packet sent by the second network node. Alternatively, the data plane of the first network node sends a measurement result (for example, a first-type statistics packet) to the second network node. A control plane of the first network node is connected to a control plane of the second network node. When the control plane of the first network node is connected to the control plane of the second network node, the control plane of the second network node is mainly responsible for sending a setting packet to the first network node to negotiate measurement parameters between the first network node and the second network node.

[0217] All or some of the foregoing embodiments may be implemented by software, hardware, firmware, or any combination thereof. When software is used to implement the embodiments, all or some of the foregoing embodiments may be implemented in a form of a computer program product. The computer program product includes one or more computer instructions. When the computer program instructions are loaded or executed on the computer, the procedure or functions according to the embodiments of the present invention are all or partially generated. The computer may be a general-purpose computer, a dedicated computer, a computer network, or other programmable apparatuses. The computer instructions may be stored in a computer-readable

storage medium or may be transmitted from a computer-readable storage medium to another computer-readable storage medium. For example, the computer instructions may be transmitted from a website, computer, server, or data center to another website, computer, server, or data center in a wired (for example, infrared, radio, or microwave) manner. The computer-readable storage medium may be any usable medium accessible by a computer, or a data storage device, such as a server or a data center, integrating one or more usable media. The usable medium may be a magnetic medium (for example, a floppy disk, a hard disk, or a magnetic tape), an optical medium (for example, a DVD), or a semiconductor medium. The semiconductor medium may be a solid-state drive.

[0218] It should be understood that, the term "and/or" in this specification describes only an association relationship for describing associated objects and represents that three relationships may exist. For example, A and/or B may represent the following three cases: Only A exists, both A and B exist, and only B exists. In addition, the character "/" in this specification usually indicates an "or" relationship between the associated objects.

[0219] A person of ordinary skill in the art may be aware that, in combination with the examples described in the embodiments disclosed in this specification, units and algorithm steps may be implemented by electronic hardware or a combination of computer software and electronic hardware. Whether the functions are performed by hardware or software depends on particular applications and design constraints of the technical solutions. A person skilled in the art may use different methods to implement the described functions for each particular application, but it should not be considered that the implementation goes beyond the scope of this application.

[0220] It may be clearly understood by a person skilled in the art that, for the purpose of convenient and brief description, for a detailed working process of the foregoing system, apparatus, and unit, refer to a corresponding process in the foregoing method embodiments. Details are not described herein again.

[0221] In the several embodiments provided in this application, it should be understood that the disclosed system, apparatus, and method may be implemented in other manners. For example, the described apparatus embodiments are merely examples. For example, division into units is merely logical function division and may be other division during actual implementation. For example, a plurality of units or components may be combined or integrated into another system, or some features may be ignored or not performed. In addition, the displayed or discussed mutual couplings or direct couplings or communication connections may be implemented through some interfaces. The indirect couplings or communication connections between the apparatuses or units may be implemented in electrical, mechanical, or another form.

[0222] The units described as separate parts may or may not be physically separate, and parts displayed as

units may or may not be physical units, may be located in one position, or may be distributed on a plurality of network units. Some or all of the units may be selected based on an actual requirement to achieve an objective of a solution of the embodiments.

[0223] In addition, functional units in the embodiments of this application may be integrated into one processing unit, or each of the units may exist alone physically, or two or more units may be integrated into one unit.

[0224] When the functions are implemented in a form of a software functional unit and sold or used as an independent product, the functions may be stored in a computer-readable storage medium. Based on such an understanding, the technical solutions of this application essentially, or the part contributing to the conventional technology, or some of the technical solutions may be implemented in a form of a software product. The computer software product is stored in a storage medium, and includes several instructions for instructing a computer device (which may be a personal computer, a server, a network device, or the like) to perform all or some of the steps of the methods described in the embodiments of this application. The foregoing storage medium includes any medium that can store program code, such as a USB flash drive, a removable hard disk, a read-only memory (read-only memory, ROM), a random access memory (random access memory, RAM), a magnetic disk, or an optical disc.

[0225] The foregoing descriptions are merely specific implementations of this application, but are not intended to limit the protection scope of this application. Any variation or replacement readily figured out by a person skilled in the art within the technical scope disclosed in this application shall fall within the protection scope of this application. Therefore, the protection scope of this application shall be subject to the protection scope of the claims. The units described as separate parts may or may not be physically separate, and parts displayed as units may or may not be physical units, may be located in one position, or may be distributed on a plurality of network units. Some or all of the units may be selected based on an actual requirement to achieve an objective of a solution of the embodiments.

Claims

1. A congestion measurement method, wherein the method is performed in a communication system comprising a first network node and a second network node, is applied to the first network node, and comprises:

receiving a first delimitation packet, wherein the first delimitation packet comprises a first identifier, and the first identifier is used to indicate a moment at which the second network node sends the first delimitation packet;

- collecting, based on the first delimitation packet, statistics about a congestion status of the first network node by using a first time interval as a periodicity, wherein the first time interval is a time interval at which the second network node sends two neighboring delimitation packets; and sending a first-type statistics packet to the second network node by using the first time interval as a periodicity, wherein the first-type statistics packet comprises the first identifier, and the first-type statistics packet is used to indicate the congestion status of the first network node in the first time interval.
2. The method according to claim 1, wherein the first-type statistics packet comprises a first receiving rate of the first network node in the first time interval.
 3. The method according to claim 1 or 2, wherein the method further comprises:

receiving a second delimitation packet at a third moment, wherein the second delimitation packet comprises a second identifier, and the second identifier is used to indicate a moment at which the second network node sends the second delimitation packet; the second delimitation packet and the first delimitation packet are two neighboring delimitation packets; and a time interval between the third moment and a first moment is greater than the first time interval, and the first moment is a moment at which the first network node receives the first delimitation packet; and finishing collecting statistics about the congestion status of the first network node based on the second delimitation packet.
 4. The method according to claim 3, wherein when the third moment and a start moment or an end moment of the first time interval do not overlap, after the finishing collecting statistics about the congestion status of the first network node based on the second delimitation packet, the method further comprises: sending a second-type statistics packet to the second network node at the third moment, wherein the second-type statistics packet comprises the first identifier, and the second-type statistics packet is used to indicate a congestion status of the first network node in a time interval between the third moment and the start moment of the first time interval in which the third moment is located.
 5. The method according to claim 4, wherein the second-type statistics packet comprises a second receiving rate of the first network node in the time interval between the third moment and the start moment of the first time interval in which the third moment is located.
 6. The method according to claim 4 or 5, wherein when the third moment and the start moment or the end moment of the first time interval do not overlap, the method further comprises:

collecting statistics about a congestion status in a time interval between the third moment and the end moment of the first time interval in which the third moment is located; and sending a third-type statistics packet to the second network node at the end moment of the first time interval in which the third moment is located, wherein the third-type statistics packet comprises the second identifier, and the third-type statistics packet is used to indicate the congestion status of the first network node in the time interval between the third moment and the end moment of the first time interval in which the third moment is located.
 7. The method according to claim 6, wherein the third-type statistics packet comprises a third receiving rate of the first network node in the time interval between the third moment and the end moment of the first time interval in which the third moment is located.
 8. The method according to any one of claims 1 to 7, wherein the method further comprises:

receiving a setting packet, wherein the setting packet is used to indicate a time interval at which the first network node collects statistics about the congestion status, and the setting packet comprises the first time interval; and setting, as the first time interval based on the setting packet, the time interval at which the first network node collects statistics about the congestion status.
 9. A congestion measurement method, wherein the method is performed in a communication system comprising a first network node and a second network node, is applied to the second network node, and comprises:

sending a first delimitation packet, wherein the first delimitation packet comprises a first identifier, and the first identifier is used to indicate a moment at which the second network node sends the first delimitation packet; sending a second delimitation packet, wherein the second delimitation packet comprises a second identifier, and the second identifier is used to indicate a moment at which the second network node sends the second delimitation packet; the second delimitation packet and the first delimitation packet are two neighboring delimitation packets; and a time interval at which the

second network node sends the two neighboring delimitation packets is a first time interval; collecting statistics about first data based on the first delimitation packet and the second delimitation packet, wherein the first data is used to indicate a congestion status in the first time interval;

receiving, by using the first time interval as a periodicity, a first-type statistics packet sent by the first network node, wherein the first-type statistics packet comprises the first identifier, and the first-type statistics packet is used to indicate a congestion status of the first network node in the first time interval; and

obtaining a first congestion degree based on the first data and the first-type statistics packet, wherein the first congestion degree is used to indicate a congestion degree in the first time interval.

10. The method according to claim 9, wherein the method further comprises:

receiving a second-type statistics packet, wherein the second-type statistics packet comprises the first identifier, the second-type statistics packet is used to indicate a congestion status of the first network node in a time interval between a third moment and a start moment of the first time interval in which the third moment is located, and the third moment is a moment at which the first network node receives the second delimitation packet; and

obtaining a second congestion degree based on the first data and the second-type statistics packet, wherein the second congestion degree is used to indicate a congestion degree in the time interval between the third moment and the start moment of the first time interval in which the third moment is located.

11. The method according to claim 9 or 10, wherein the method further comprises:

receiving a third-type statistics packet, wherein the third-type statistics packet comprises the second identifier, and the third-type statistics packet is used to indicate a congestion status of the first network node in a time interval between the third moment and an end moment of the first time interval in which the third moment is located;

collecting statistics about second data, wherein the second data is used to indicate a congestion status in the first time interval between a fourth moment and a fifth moment, the fourth moment is a moment at which the second network node sends the second delimitation packet, a time in-

terval between the fifth moment and the fourth moment is the first time interval, and the fifth moment is later than the fourth moment;

obtaining a third congestion degree based on the second data and the third-type statistics packet, wherein the third congestion degree is used to indicate a congestion degree in the time interval between the third moment and the end moment of the first time interval in which the third moment is located; and

obtaining a fourth congestion degree based on the second congestion degree and the third congestion degree, wherein the fourth congestion degree is used to indicate a congestion degree in the first time interval in which the third moment is located.

12. The method according to any one of claims 9 to 11, wherein the method further comprises:

sending a setting packet, wherein the setting packet is used to indicate a time interval at which the first network node collects statistics about the congestion status, and the setting packet comprises the first time interval.

13. A network node, wherein the network node comprises a first network node and a second network node, the network node is the first network node, and the network node comprises:

a receiving module, configured to receive a first delimitation packet, wherein the first delimitation packet comprises a first identifier, and the first identifier is used to indicate a moment at which the second network node sends the first delimitation packet;

a processing module, configured to collect, based on the first delimitation packet, statistics about a congestion status of the network node by using a first time interval as a periodicity, wherein the first time interval is a time interval at which the second network node sends two neighboring delimitation packets; and

a sending module, configured to send a first-type statistics packet to the second network node by using the first time interval as a periodicity, wherein the first-type statistics packet comprises the first identifier, and the first-type statistics packet is used to indicate a congestion status of the network node in the first time interval.

14. The network node according to claim 13, wherein the first-type statistics packet comprises a first receiving rate of the network node in the first time interval.

15. The network node according to claim 13 or 14,

wherein the receiving module is further configured to: receive a second delimitation packet at a third moment, wherein the second delimitation packet comprises a second identifier, and the second identifier is used to indicate a moment at which the second network node sends the second delimitation packet; the second delimitation packet and the first delimitation packet are two neighboring delimitation packets; a time interval between the third moment and a first moment is greater than the first time interval, and the first moment is a moment at which the network node receives the first delimitation packet; and the processing module is further configured to: finish collecting statistics about the congestion status of the network node based on the second delimitation packet.

16. The network node according to claim 15, wherein when the third moment and a start moment or an end moment of the first time interval do not overlap, the sending module is further configured to: send a second-type statistics packet to the second network node at the third moment, wherein the second-type statistics packet comprises the first identifier, and the second-type statistics packet is used to indicate a congestion status of the network node in a time interval between the third moment and the start moment of the first time interval in which the third moment is located.
17. The network node according to claim 16, wherein the second-type statistics packet comprises a second receiving rate of the network node in the time interval between the third moment and the start moment of the first time interval in which the third moment is located.
18. The network node according to any one of claims 15 to 17, wherein when the third moment and the start moment or the end moment of the first time interval do not overlap, the processing module is further configured to:

collect statistics about a congestion status in a time interval between the third moment and the end moment of the first time interval in which the third moment is located; and

the sending module is further configured to: send a third-type statistics packet to the second network node at the end moment of the first time interval in which the third moment is located, wherein the third-type statistics packet comprises the second identifier, and the third-type statistics packet is used to indicate the congestion status of the network node in the time interval between the third moment and the end moment of the first time interval in which the third moment

is located.

19. The network node according to claim 18, wherein the third-type statistics packet comprises a third receiving rate of the network node in the time interval between the third moment and the end moment of the first time interval in which the third moment is located.
20. The network node according to any one of claims 13 to 19, wherein the receiving module is further configured to:

receive a setting packet, wherein the setting packet is used to indicate a time interval at which the network node collects statistics about the congestion status, and the setting packet comprises the first time interval; and

the processing module is further configured to: set, as the first time interval based on the setting packet, the time interval at which the network node collects statistics about the congestion status.
21. A network node, wherein the network node comprises a first network node and a second network node, the network node is the second network node, and the network node comprises:

a sending module, configured to send a first delimitation packet, wherein the first delimitation packet comprises a first identifier, and the first identifier is used to indicate a moment at which the network node sends the first delimitation packet, wherein

the sending module is further configured to send a second delimitation packet, wherein the second delimitation packet comprises a second identifier, and the second identifier is used to indicate a moment at which the network node sends the second delimitation packet; the second delimitation packet and the first delimitation packet are two neighboring delimitation packets; and a time interval at which the second network node sends the two neighboring delimitation packets is a first time interval;

a processing module, configured to collect statistics about first data based on the first delimitation packet and the second delimitation packet, wherein the first data is used to indicate a congestion status in the first time interval; and

a receiving module, configured to receive, by using the first time interval as a periodicity, a first-type statistics packet sent by the first network node, wherein the first-type statistics packet comprises the first identifier, and the first-type statistics packet is used to indicate a congestion status of the first network node in the first time

interval, wherein

the processing module is further configured to obtain a first congestion degree based on the first data and the first-type statistics packet, wherein the first congestion degree is used to indicate a congestion degree in the first time interval.

- 22.** The network node according to claim 21, wherein the receiving module is further configured to:

receive a second-type statistics packet, wherein the second-type statistics packet comprises the first identifier, the second-type statistics packet is used to indicate a congestion status of the first network node in a time interval between a third moment and a start moment of the first time interval in which the third moment is located, and the third moment is a moment at which the first network node receives the second delimitation packet; and

the processing module is further configured to: obtain a second congestion degree based on the first data and the second-type statistics packet, wherein the second congestion degree is used to indicate a congestion degree in the time interval between the third moment and the start moment of the first time interval in which the third moment is located.

- 23.** The network node according to claim 20 or 21, wherein the receiving module is further configured to:

receive a third-type statistics packet, wherein the third-type statistics packet comprises the second identifier, and the third-type statistics packet is used to indicate a congestion status of the first network node in a time interval between the third moment and an end moment of the first time interval in which the third moment is located; and

the processing module is further configured to: collect statistics about second data, wherein the second data is used to indicate a congestion status in the first time interval between a fourth moment and a fifth moment, the fourth moment is a moment at which the second network node sends the second delimitation packet, a time interval between the fifth moment and the fourth moment is the first time interval, and the fifth moment is later than the fourth moment;

obtain a third congestion degree based on the second data and the third-type statistics packet, wherein the third congestion degree is used to indicate a congestion degree in the time interval between the third moment and the end moment of the first time interval in which the third moment is located; and

obtain a fourth congestion degree based on the second congestion degree and the third congestion degree, wherein the fourth congestion degree is used to indicate a congestion degree in the first time interval in which the third moment is located.

- 24.** The network node according to any one of claims 21 to 23, wherein the sending module is further configured to:

send a setting packet, wherein the setting packet is used to indicate a time interval at which the first network node collects statistics about the congestion status, and the setting packet comprises the first time interval.

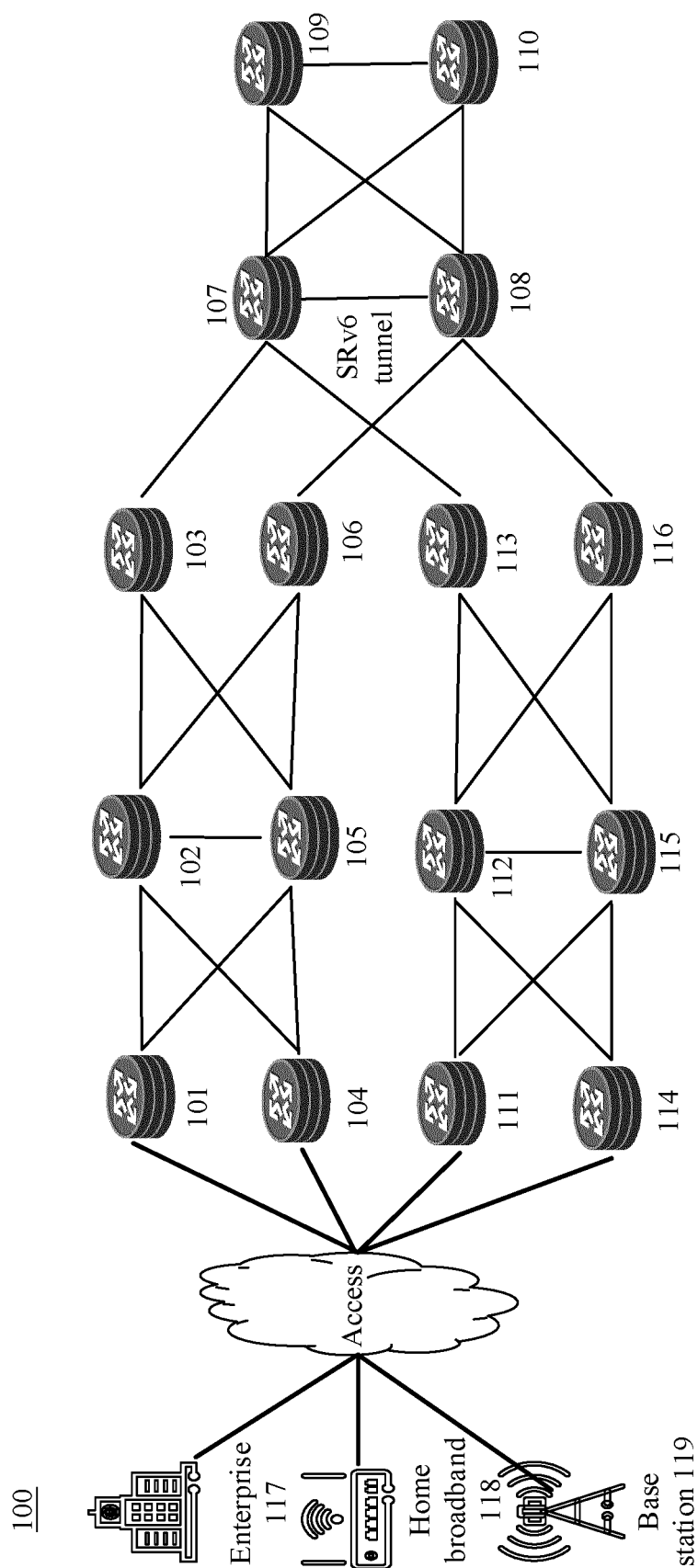


FIG. 1

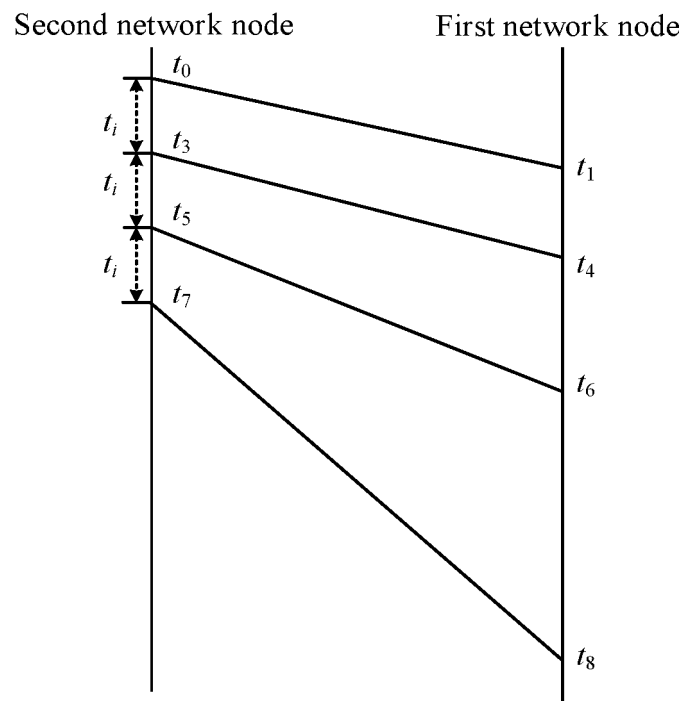


FIG. 2

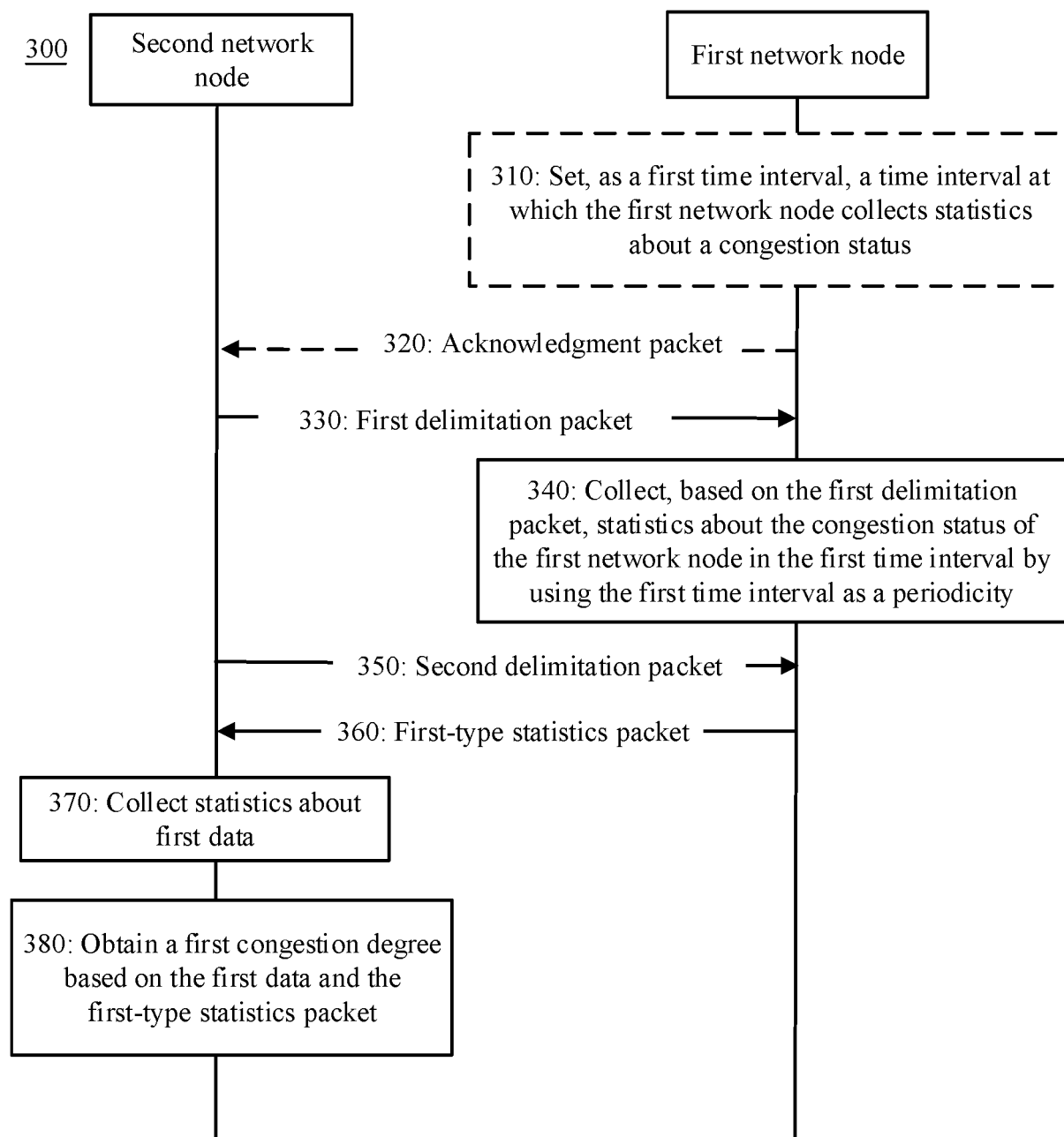


FIG. 3

Packet type (ControlCode)	Reserved (Reserve)	Reserved (Reserve)
Tunnel identifier (Session id) path identifier (Path ID)		
Statistics interval time (Interval time)		

FIG. 4

Packet type (ControlCode)	Accept (Accept)	Reserved (Reserve)
Tunnel identifier (Session id) path identifier (Path ID)		
Statistics interval time (Interval time)		

FIG. 5

Tunnel identifier (Session id) path identifier (Path ID)		}	Packet header (Header)
Data-area-stored data type (Path-E2E-Type)			
Packet type (Flags)	Transaction number (Transaction ID)		
Data (Data)		}	Data (Data)

FIG. 6

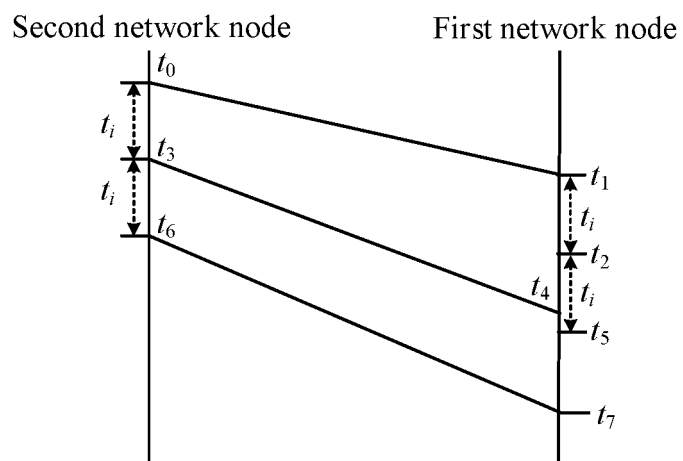


FIG. 7

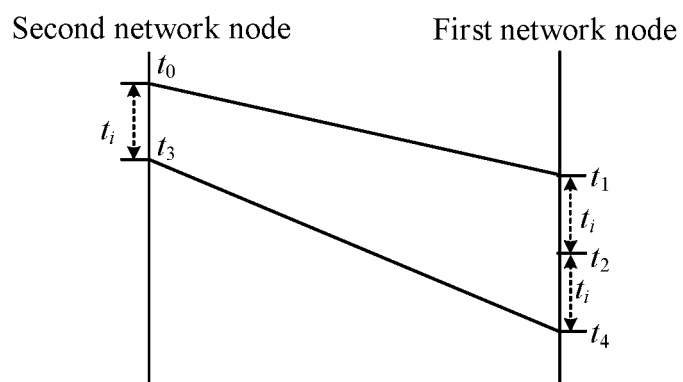


FIG. 8

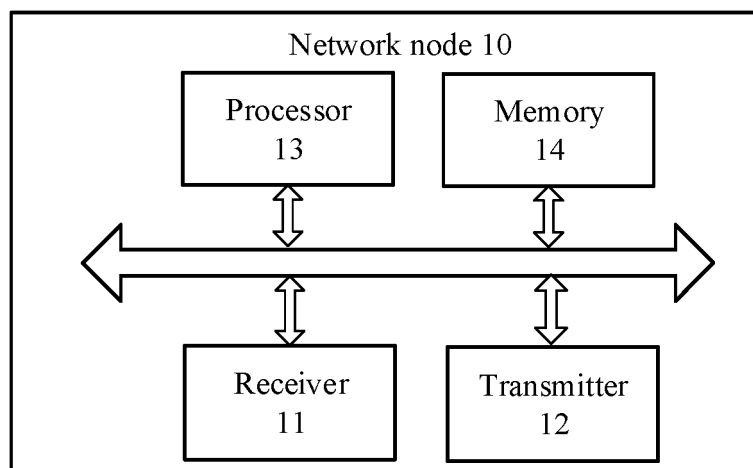


FIG. 9

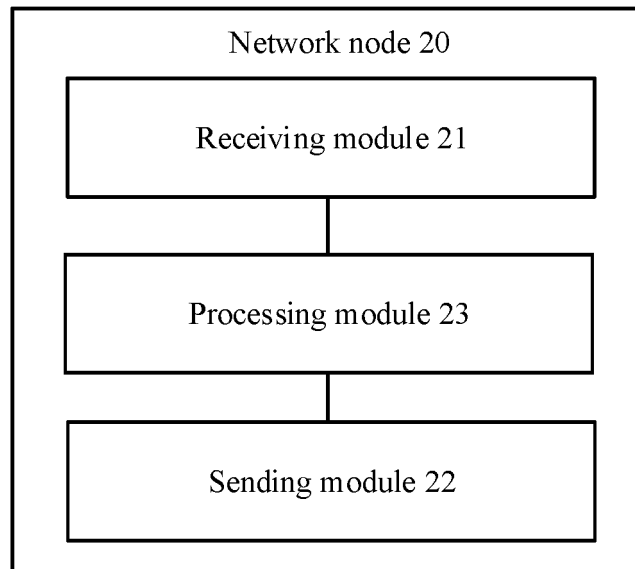


FIG. 10

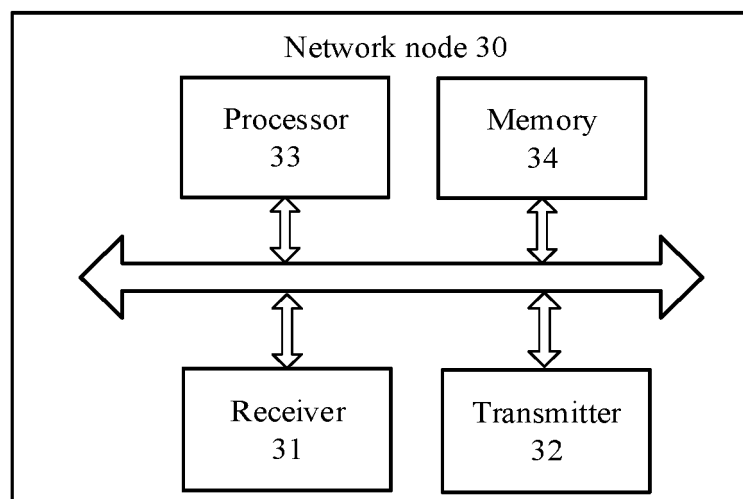


FIG. 11

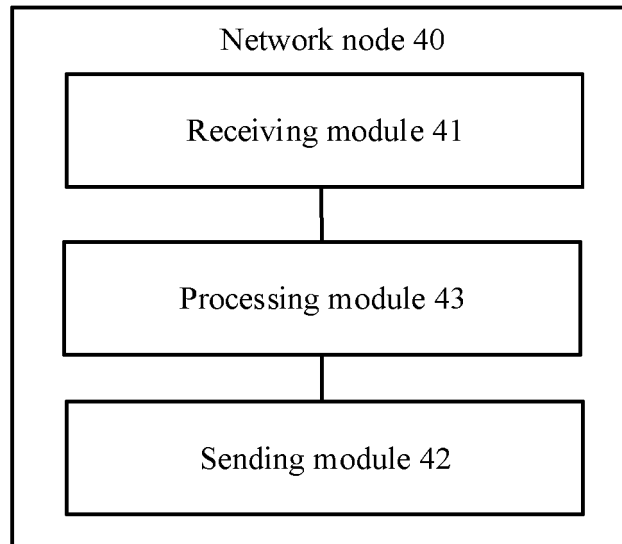


FIG. 12

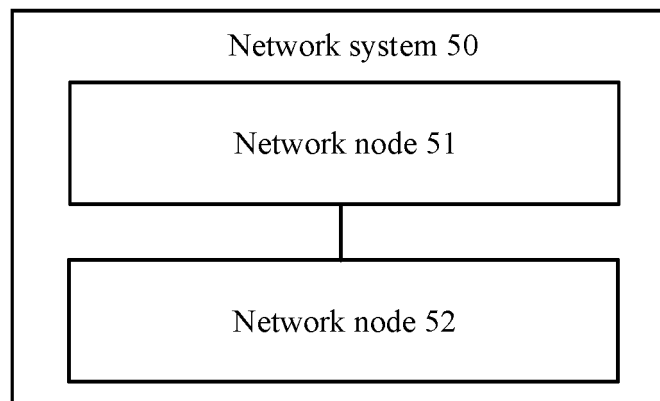


FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2020/097315

A. CLASSIFICATION OF SUBJECT MATTER

H04L 12/26(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04L; H04W; H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNKI, CNPAT, WPI, EPODOC, 3GPP: 时刻, 时间, 开始, 起始, 检测, 统计, 定界报文, 监测, 周期, 测量, 拥塞, 间接, packet, message, detect, measure, monitor, congestion, time, interval, period.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 105791008 A (HUAWEI TECHNOLOGIES CO., LTD.) 20 July 2016 (2016-07-20) description, paragraphs 57-64	1-24
A	CN 105704057 A (HUAWEI TECHNOLOGIES CO., LTD.) 22 June 2016 (2016-06-22) entire document	1-24
A	WO 2016043891 A1 (QUALCOMM INC.) 24 March 2016 (2016-03-24) entire document	1-24
A	WO 2016029195 A2 (SEVEN NETWORKS, LLC) 25 February 2016 (2016-02-25) entire document	1-24

☐ Further documents are listed in the continuation of Box C.
 ☒ See patent family annex.

* Special categories of cited documents:

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“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

14 August 2020

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2020/097315

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	105791008	A	20 July 2016	None			
CN	105704057	A	22 June 2016	None			
WO	2016043891	A1	24 March 2016	EP	3195665	A1	26 July 2017
				JP	2017532867	A	02 November 2017
				CN	106717073	A	24 May 2017
				US	2016088567	A1	24 March 2016
WO	2016029195	A2	25 February 2016	US	2018317122	A1	01 November 2018
				US	2017339596	A1	23 November 2017
				US	2016057651	A1	25 February 2016

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 201910586703X [0001]